

# KIC 008816310

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
008816310-01	OBS	No	1.778418	133.372527	43.2	5.138	12.5	9.9	1.63	7268	1.82	6466.61
008816310-02	OBS	No	1.778513	132.994912	28.6	13.482	13.7	11.5	1.63	7268	0.89	6466.15
008816310-03	OBS	No	18.408321	149.891981	340.6	1.687	22.4	18.9	1.63	7268	3.32	286.66
008816310-04	OBS	No	20.754171	135.005786	441.9	2.500	12.7	-1.0	1.63	7268	3.49	244.29

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
008816310-01	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_SKYE_ZUMA_TRACKER—LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—MOD_NONUNIQ_ALT
008816310-02	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_SKYE_ZUMA_TRACKER—LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—SAME_NTL_PERIOD
008816310-03	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_SKYE—TRANS_GAPPED—LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—MOD_NONUNIQ_ALT
008816310-04	OBS	FP	0.00	1	0	1	0	INDIV_TRANS_RUBBLE—TRANS_GAPPED—LPP_DV—LPP_ALT—MOD_NONUNIQ_ALT—MOD_TER_ALT—MOD_POS_ALT—CENT_NOFITS—HALO_GHOST

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

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

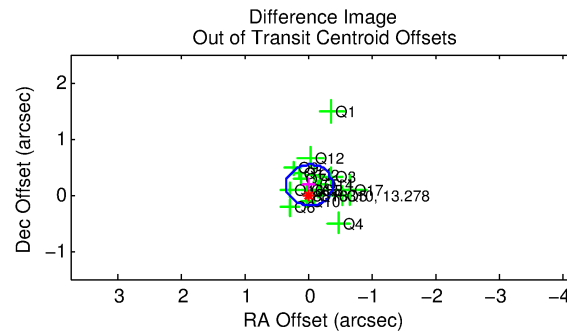
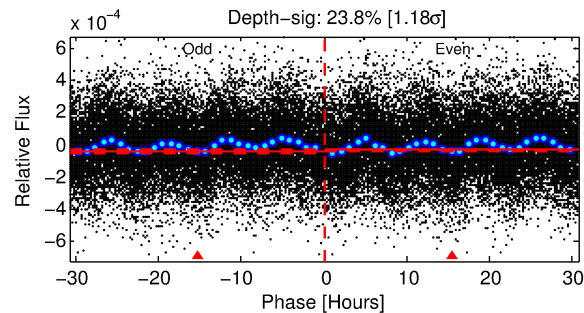
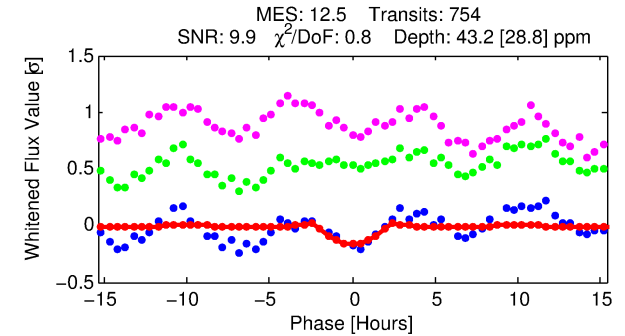
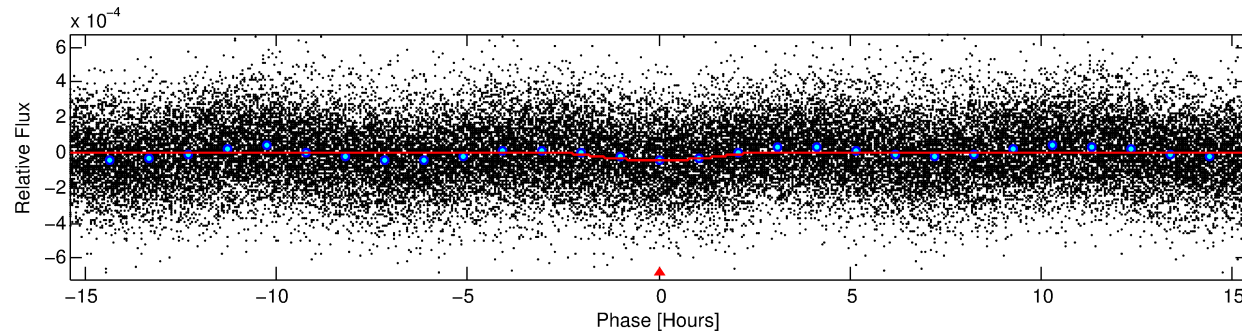
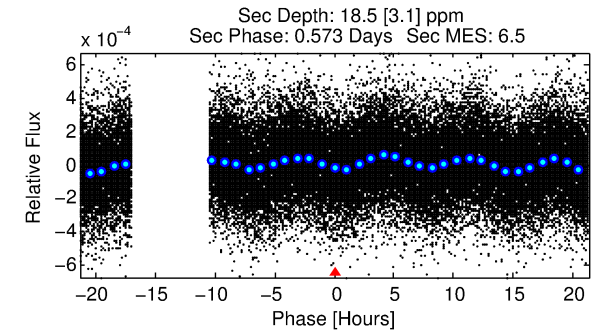
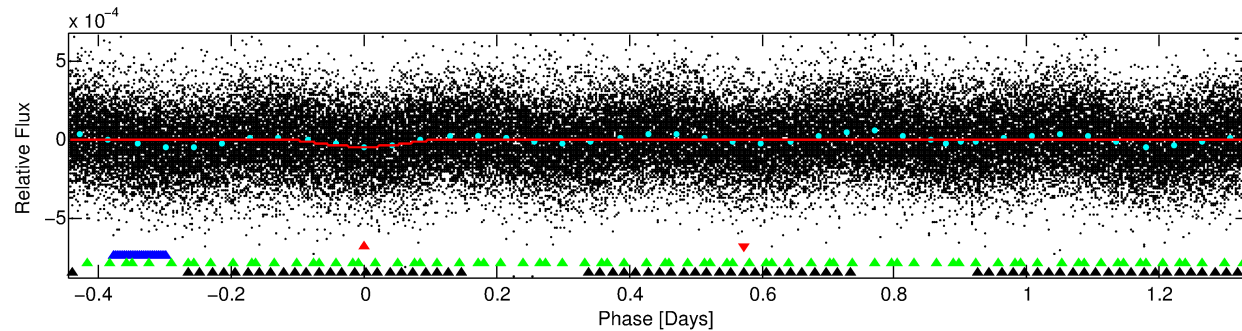
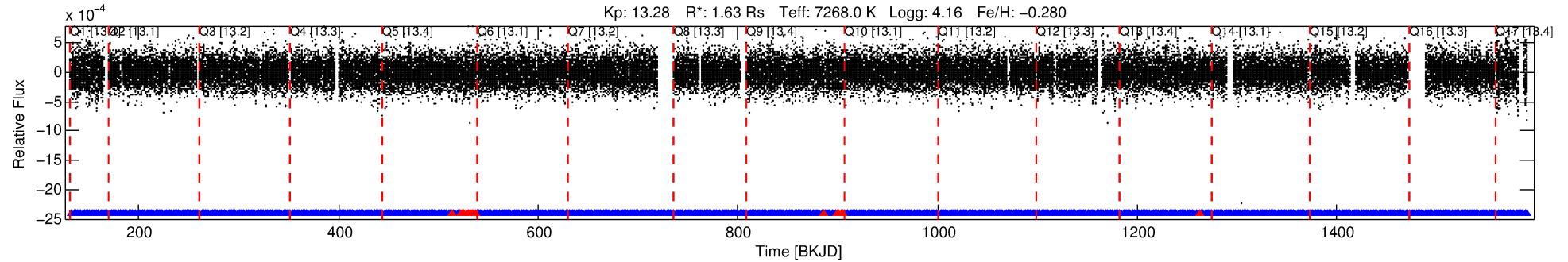
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

Ephemeris Match Information For 008816310-01

No Significant Match Found

# DV One-Page Summary

KIC: 8816310 Candidate: 1 of 4 Period: 1.778 d



## DV Fit Results:

Period = 1.77842 [0.00002] d  
Epoch = 133.3725 [0.0077] BKJD  
Rp/R\* = 0.0102 [0.0102]  
a/R\* = 1.09 [0.05]  
b = 1.00 [0.02]  
Seff = 6466.61 [2507.63]  
Teq = 2287 [222] K  
Rp = 1.82 [1.91] Re  
a = 0.0321 [0.0082] AU  
Ag = 3.16 [6.42] [0.34σ]  
Teffp = 4713 [2370] K [1.02σ]

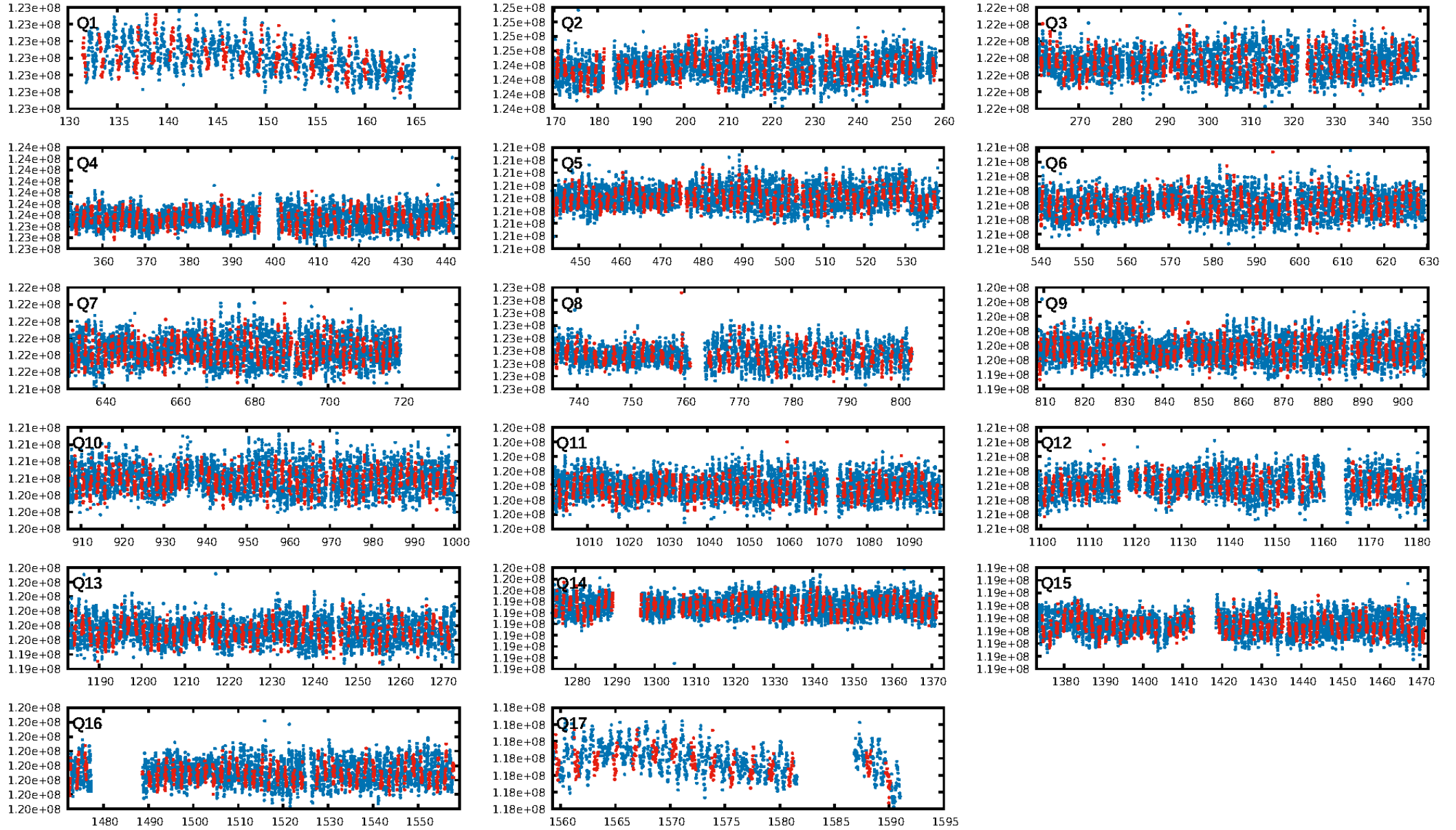
## DV Diagnostic Results:

ShortPeriod-sig: N/A  
LongPeriod-sig: 0.0% [0.00σ]  
ModelChiSquare2-sig: N/A  
ModelChiSquareGof-sig: N/A  
Bootstrap-pfa: 8.29e-138  
RollingBand-fgt: 0.98 [704/720]  
GhostDiagnostic-chr: -7.942  
Centroid-sig: 47.4%  
Centroid-so: 0.797 arcsec [1.05σ]  
OotOffset-rm: 0.171 arcsec [1.41σ]  
KicOffset-rm: 0.101 arcsec [0.79σ]  
OotOffset-st: 4/4/4/5 [17]  
KicOffset-st: 4/4/4/5 [17]  
DiffImageQuality-fgm: 1.00 [17/17]  
DiffImageOverlap-fno: 0.00 [0/17]

Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 31-Jan-2016 19:05:49 Z

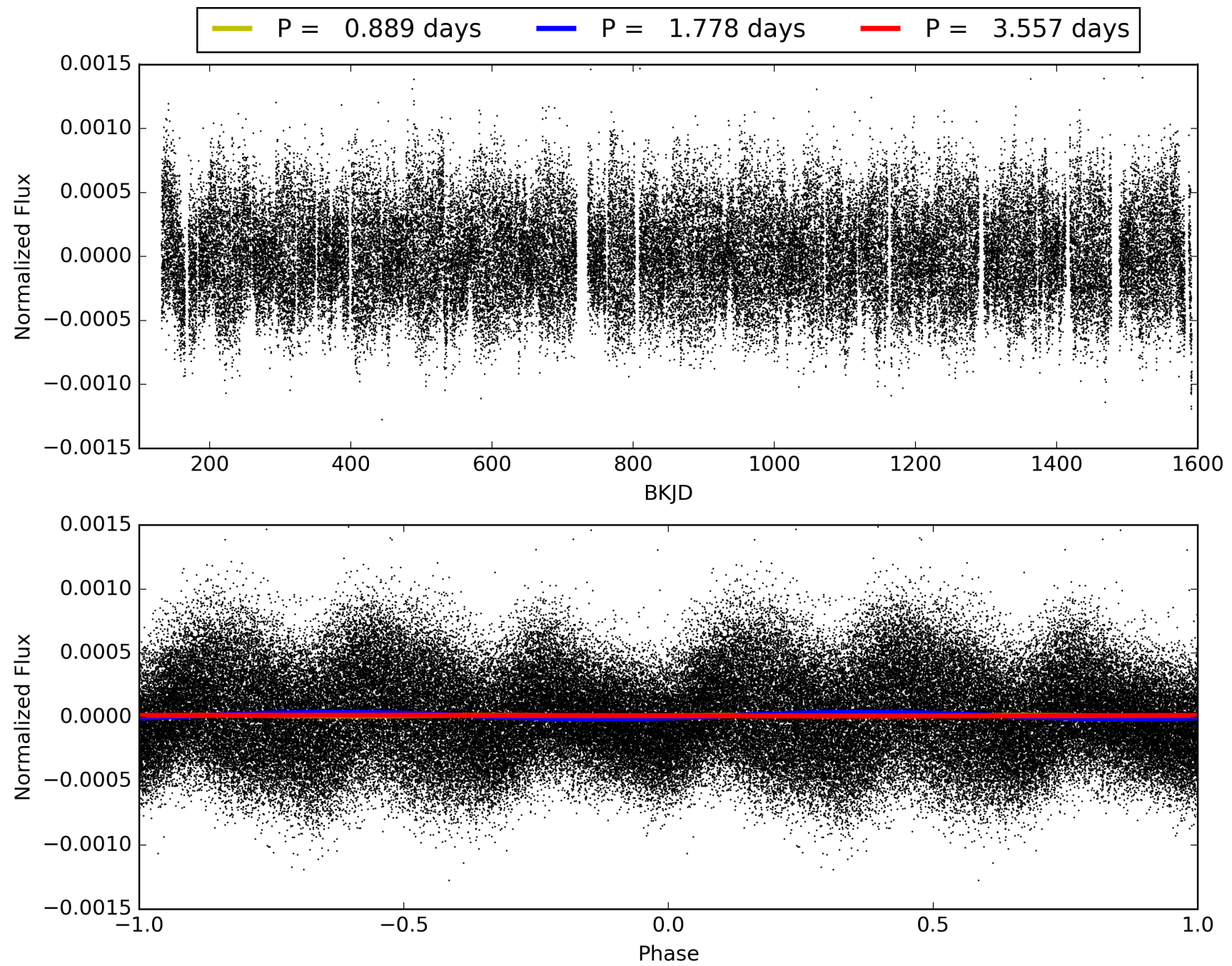
This Data Validation Report Summary was produced in the Kepler Science Operations Center Pipeline at NASA Ames Research Center

# TCE 008816310-01, PDC Light Curves





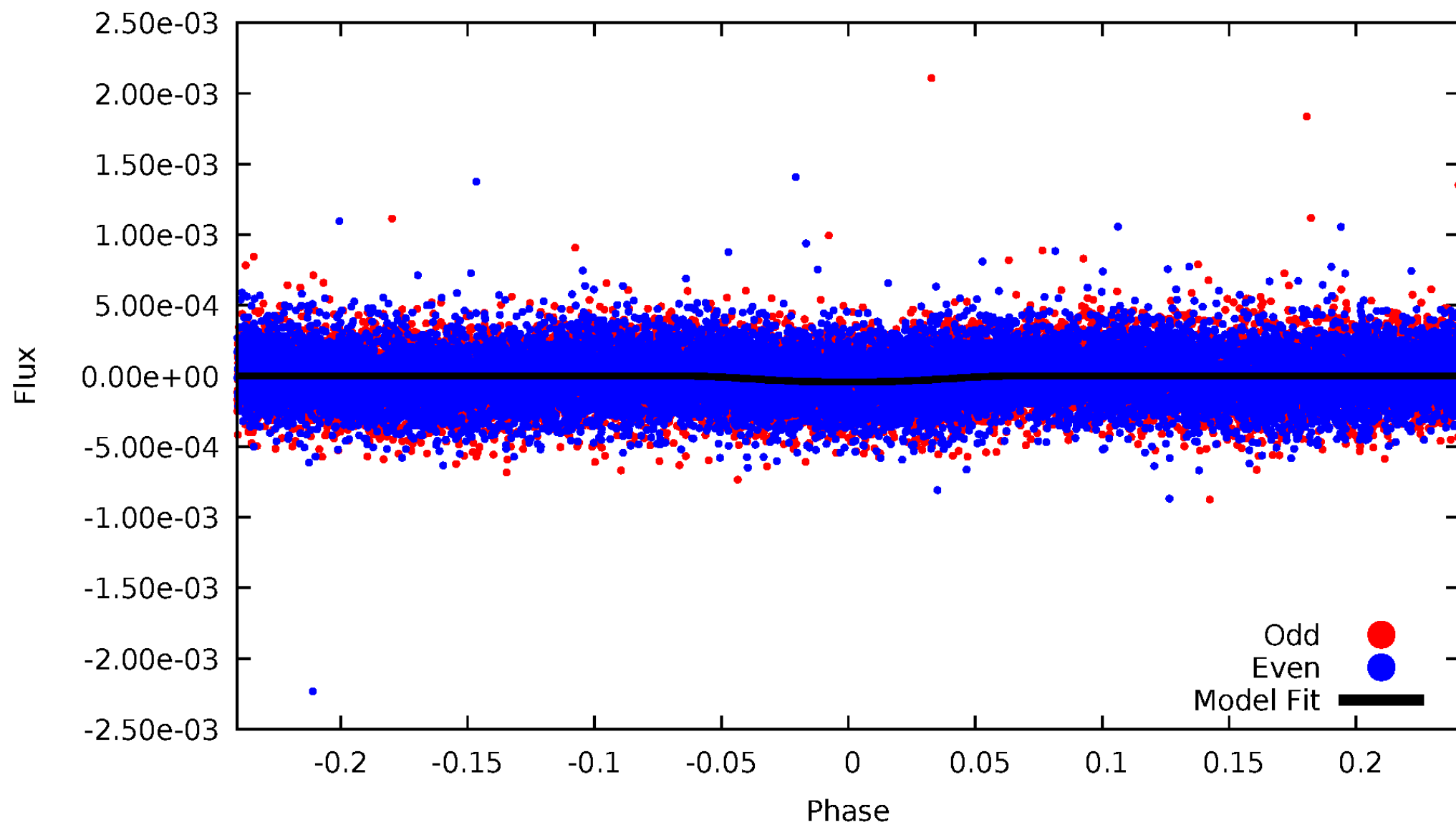
# TCE 008816310-01





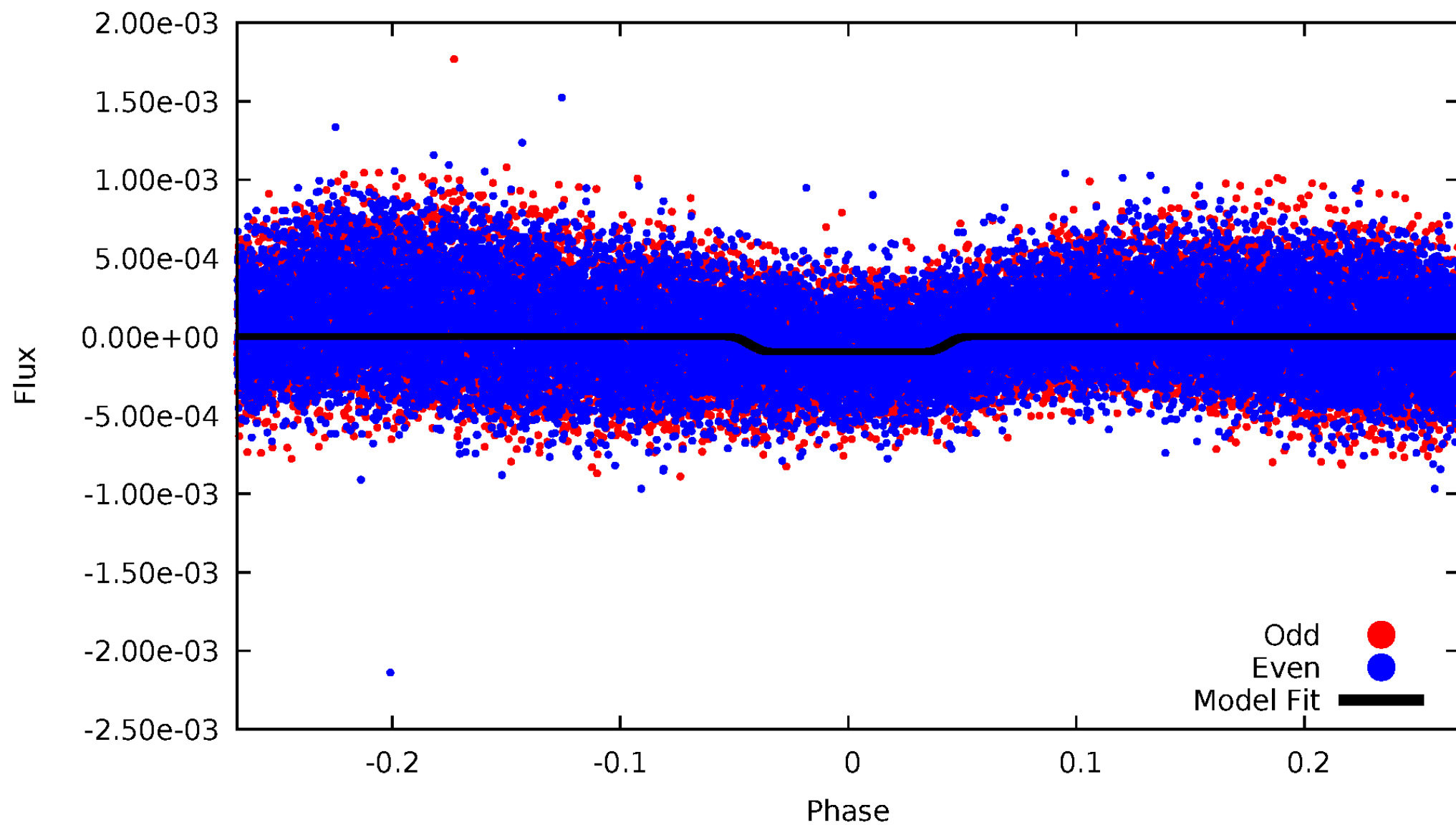
# DV Odd/Even

TCE 008816310-01

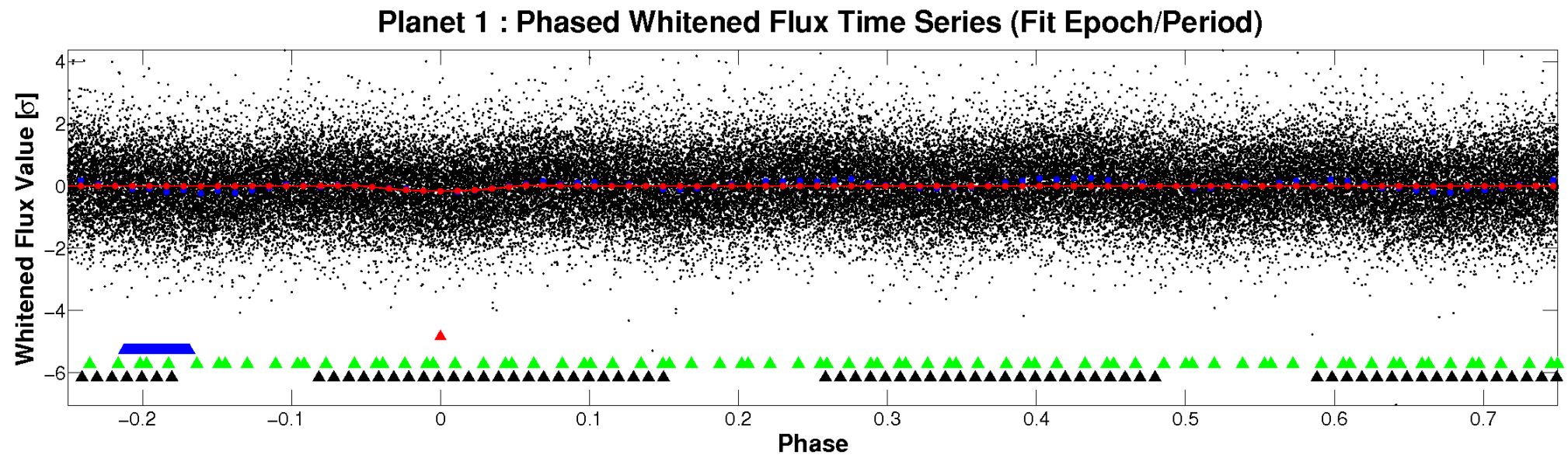
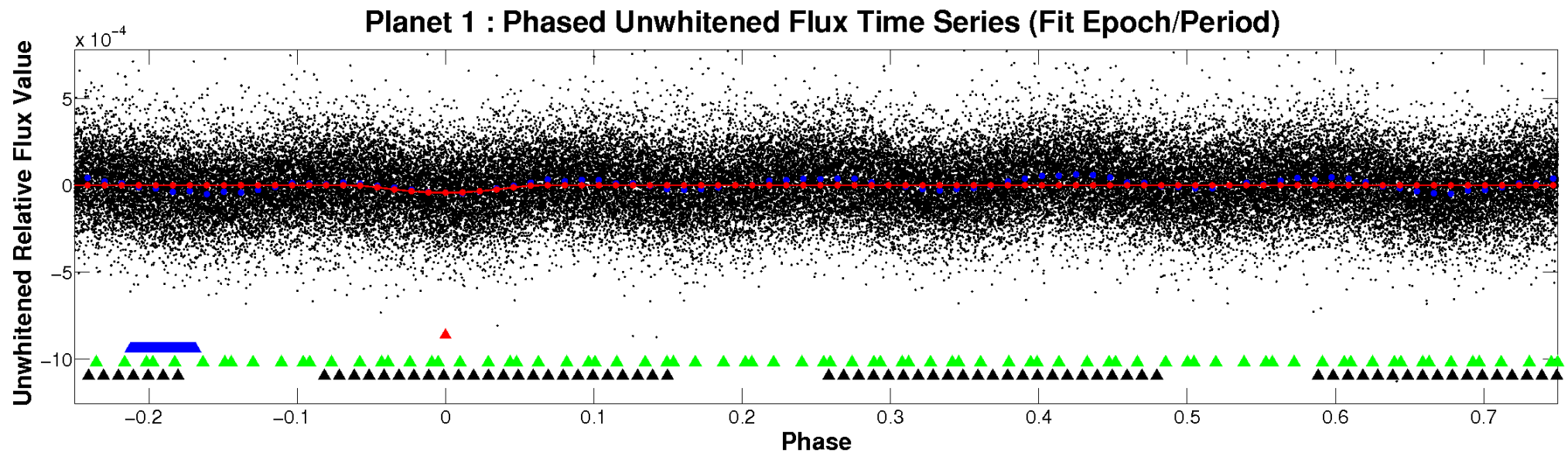


# ALT Odd/Even

TCE 008816310-01



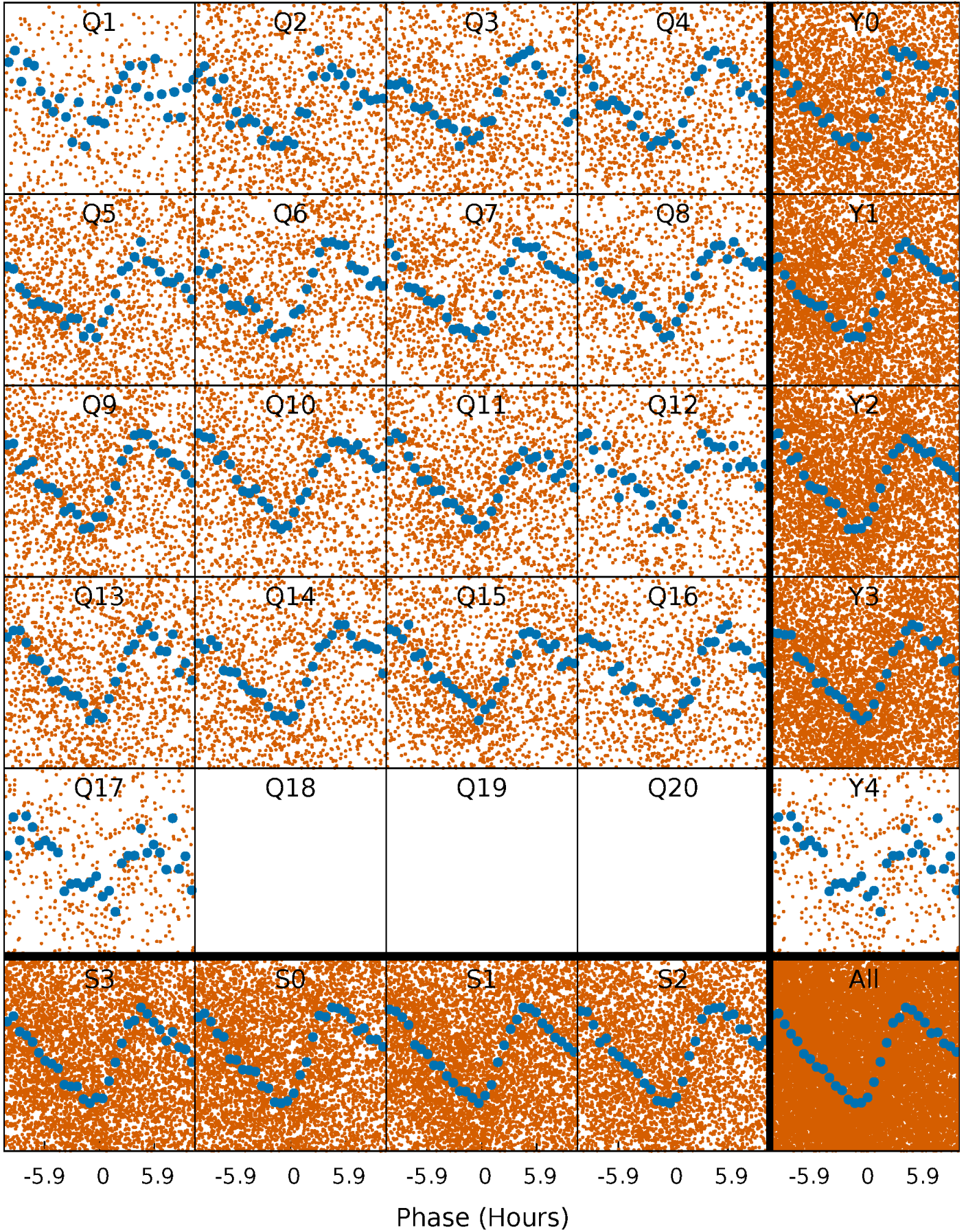
# Non-Whitened Vs. Whitened Light Curve





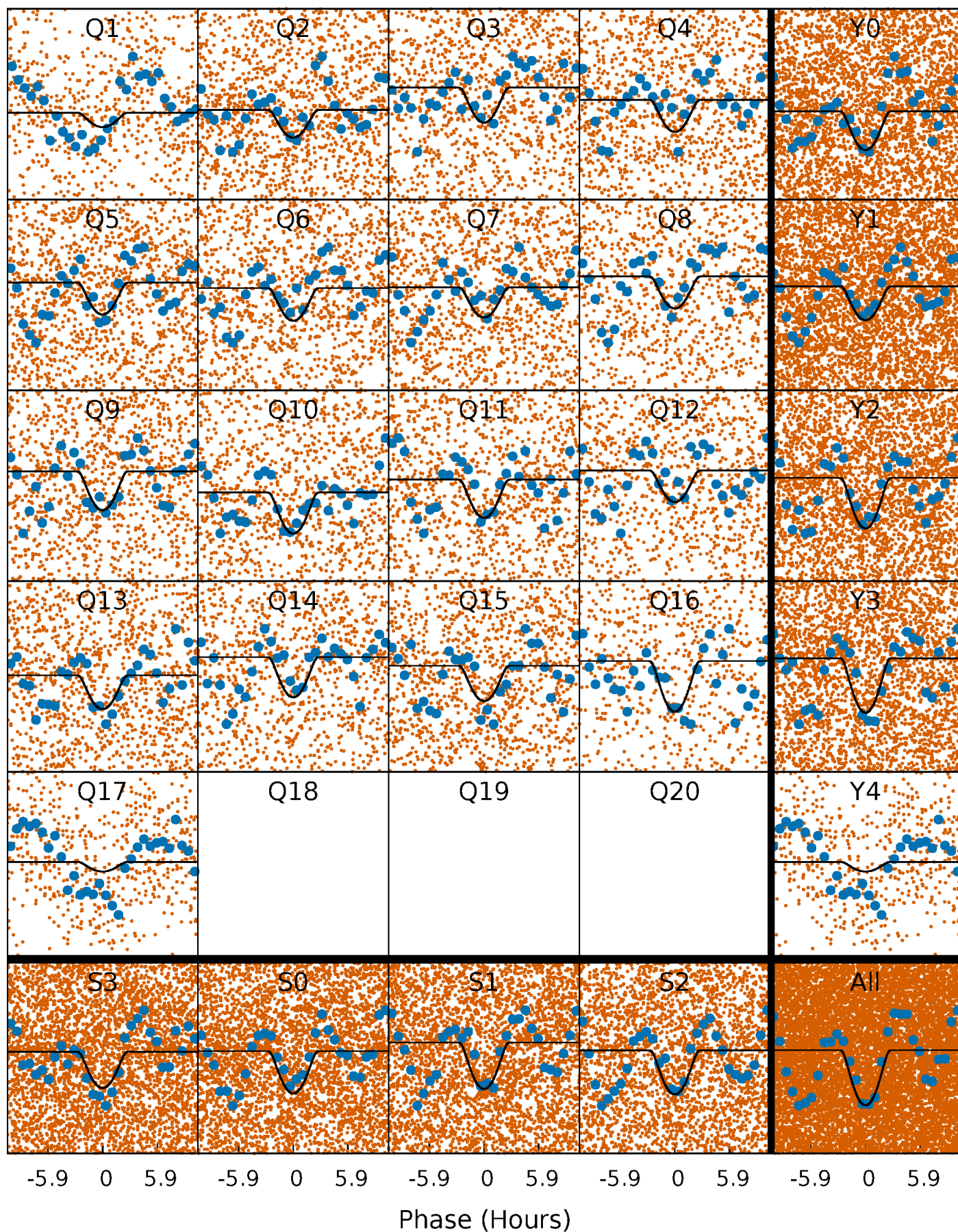
# PDC Quarter-Phased Transit Curves

TCE 008816310-01 P= 1.778418 Days  $T_0=133.372527$  (BKJD)



# DV Quarter-Phased Transit Curves

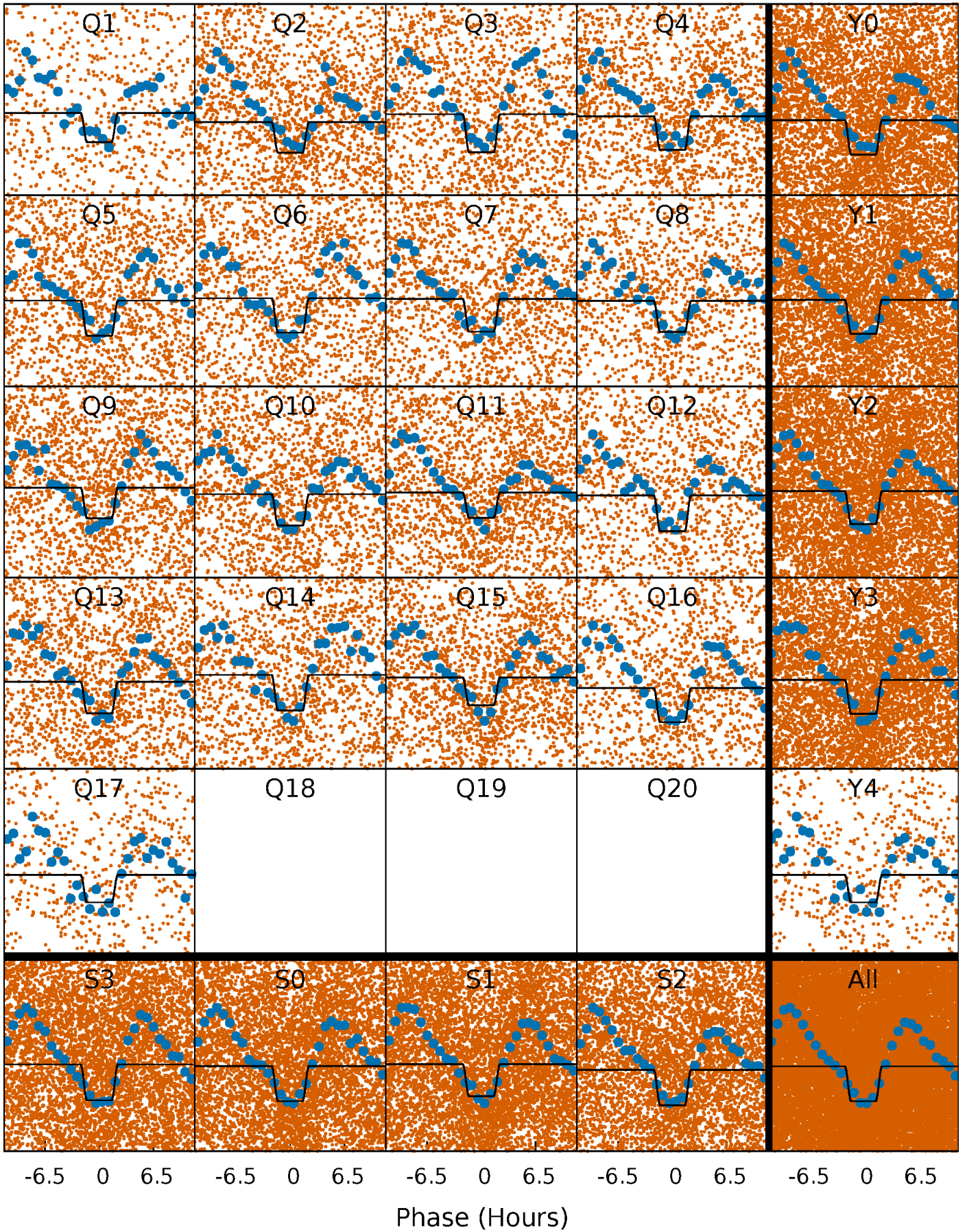
TCE 008816310-01 P= 1.778418 Days  $T_0=133.372527$  (BKJD)





# Alt. Detrend Quarter-Phased Transit Curves

TCE 008816310-01 P= 1.778479 Days  $T_0=133.314271$  (BKJD)

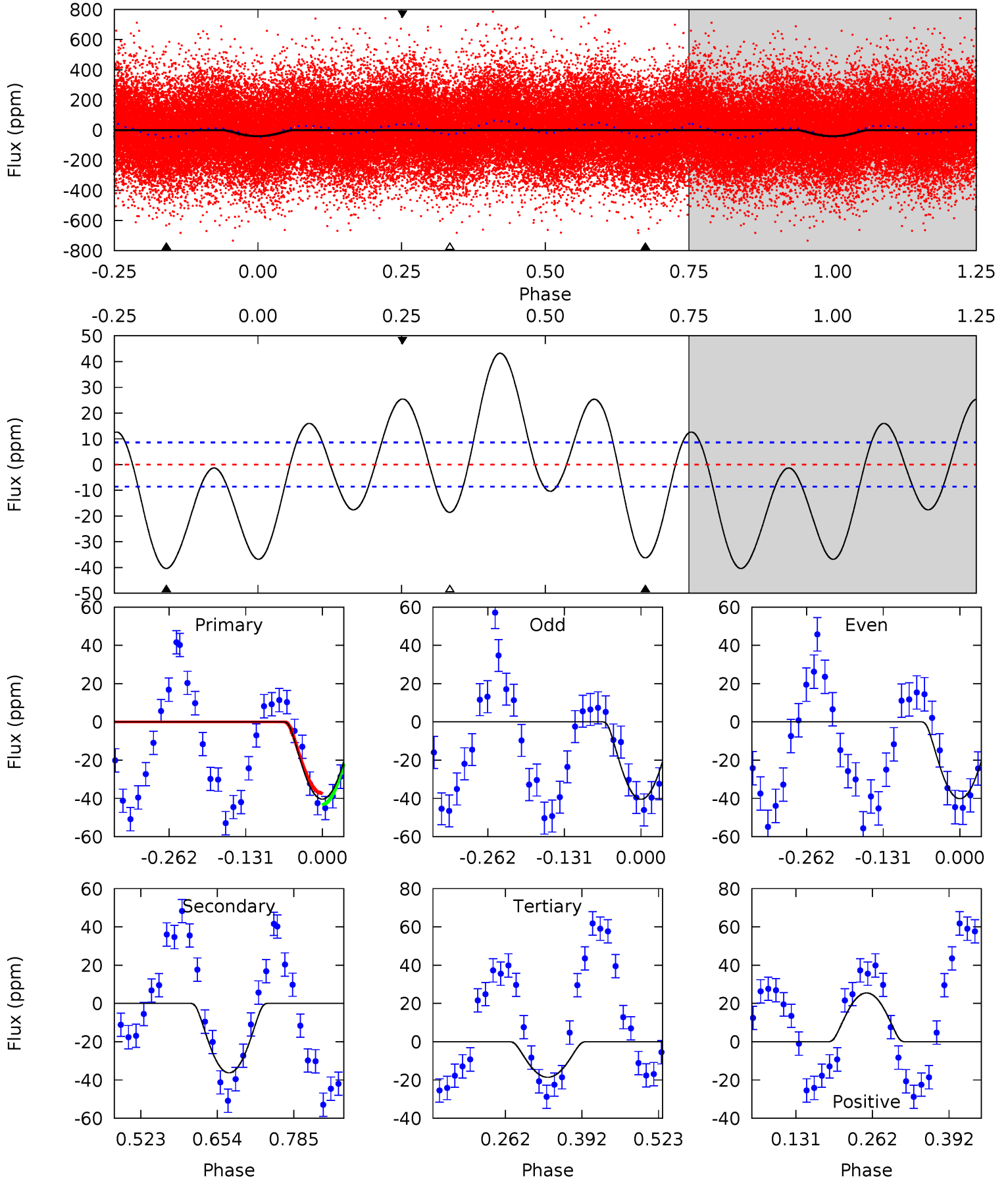




# DV Model-Shift Uniqueness Test

008816310-01, P = 1.778418 Days, E = 129.815691 Days

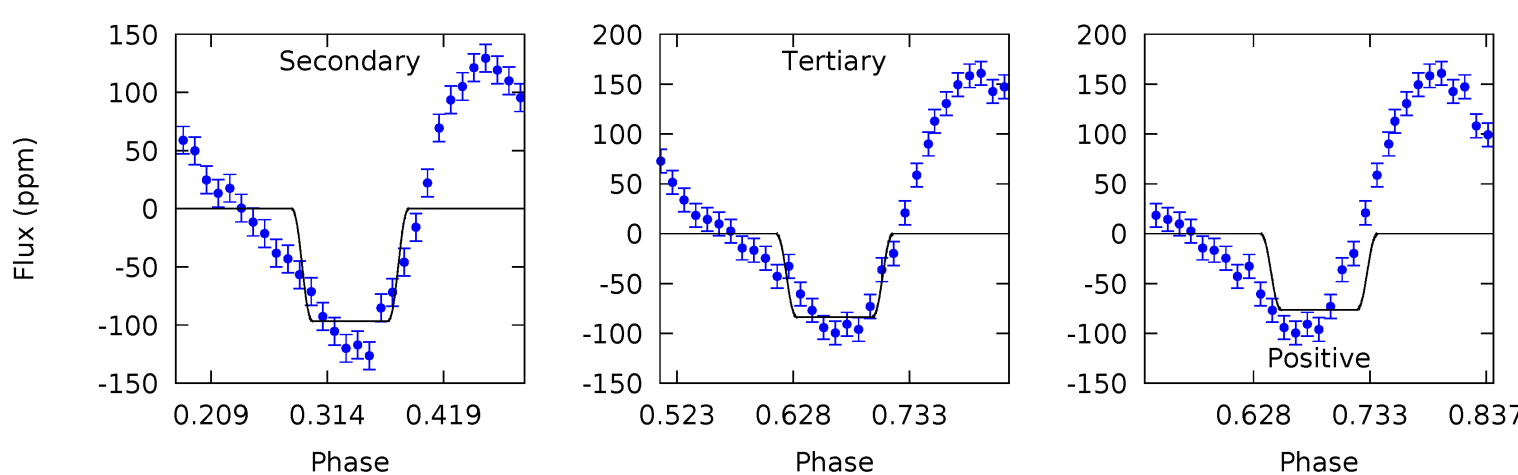
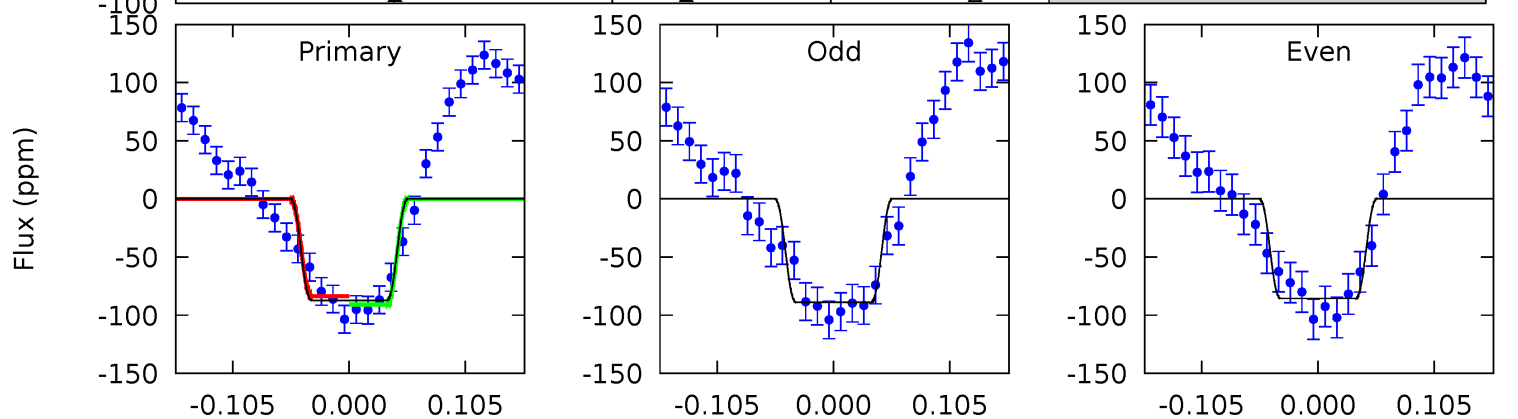
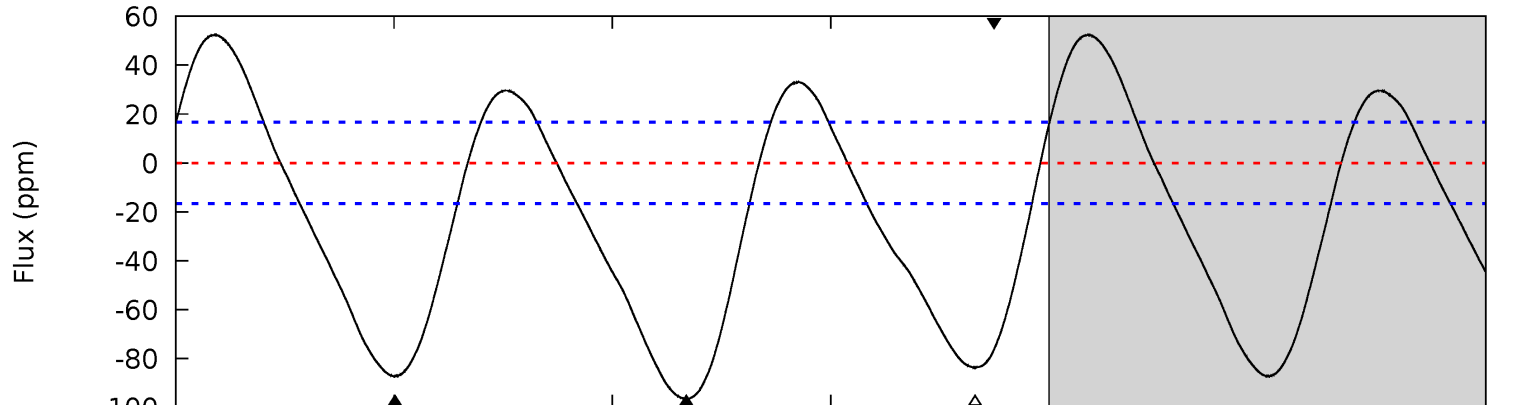
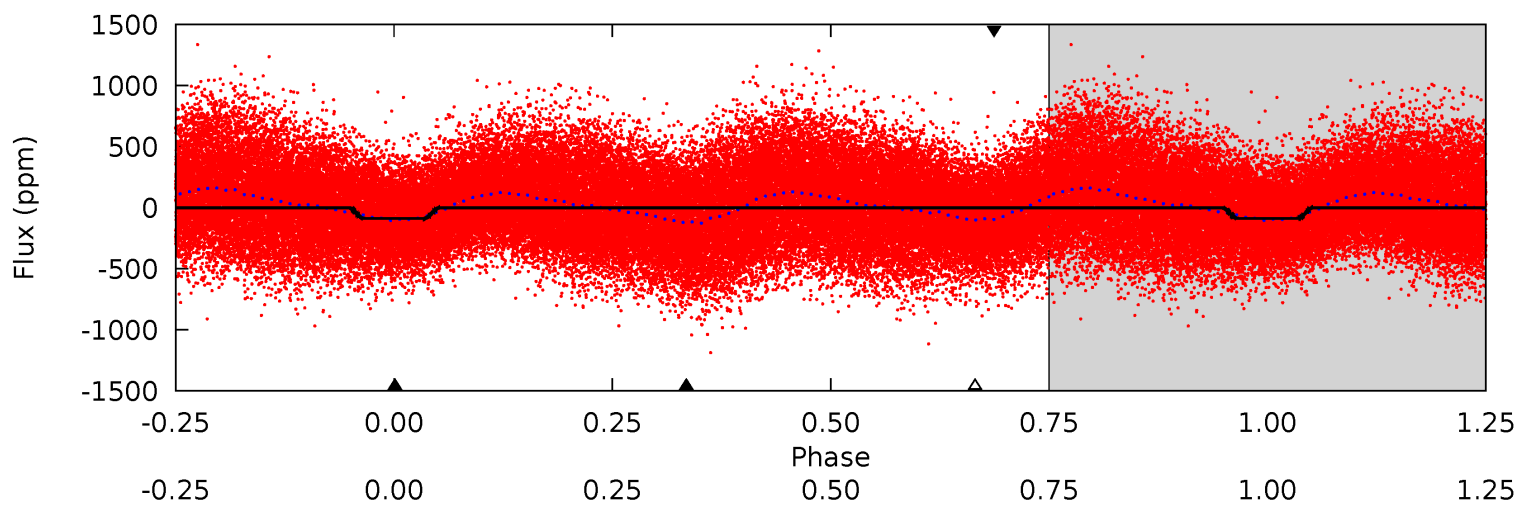
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
21.2	19.0	9.76	13.4	4.51	1.51	10.6	11.4	7.82	9.28	5.66	0.09	1.18	0.52	1.50



# Alt Model-Shift Uniqueness Test

008816310-01, P = 1.778479 Days, E = 129.757313 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
23.9	26.4	22.9	-20.9	4.56	1.62	11.0	0.97	44.8	3.52	47.4	0.44	1.05	0.35	0.95



### Stellar Parameters For KIC 008816310

	$T_{\text{eff}}(K)$	$\log(g)$	$[\text{Fe}/\text{H}]$	$R (R_{\odot})$	$M(M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$7268^{+228}_{-304}$	$4.157^{+0.148}_{-0.181}$	$-0.280^{+0.250}_{-0.350}$	$1.634^{+0.521}_{-0.347}$	$1.399^{+0.204}_{-0.226}$	$0.451^{+0.387}_{-0.220}$
	+3%/-4%	+4%/-4%	+89%/-125%	+32%/-21%	+15%/-16%	+86%/-49%
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 008816310-01 / KOI

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{\text{max}} (K)$	$T_{\text{obs}} (K)$	$A_{\text{obs}}$
DV	$-36 \pm 2$	$2.24^{+1.74}_{-1.38}$	$3201^{+271}_{-226}$	$4935^{+3348}_{-1044}$	$4.195^{+22.814}_{-2.933}$
Alt.	$-96 \pm 4$	$2.07^{+1.89}_{-1.36}$	$3199^{+258}_{-214}$	$6596^{+7353}_{-1783}$	$12^{+100}_{-9}$

$T_{\text{max}}$  = 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

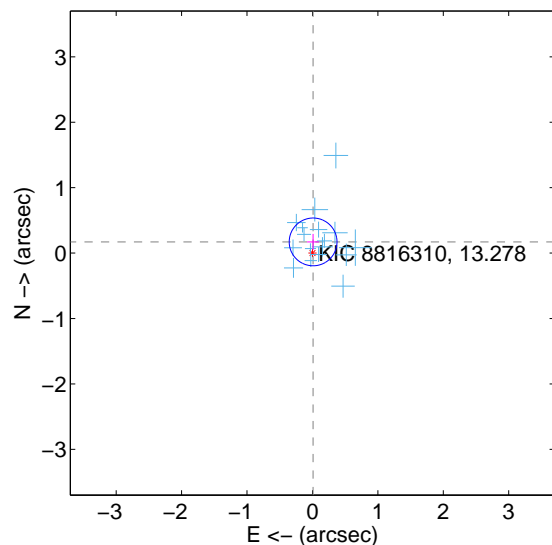
Supplemental centroid analysis for 008816310-01. Kepler magnitude: 13.28. Transit SNR 9.86

There are 17 quarters with good PRF difference image offsets

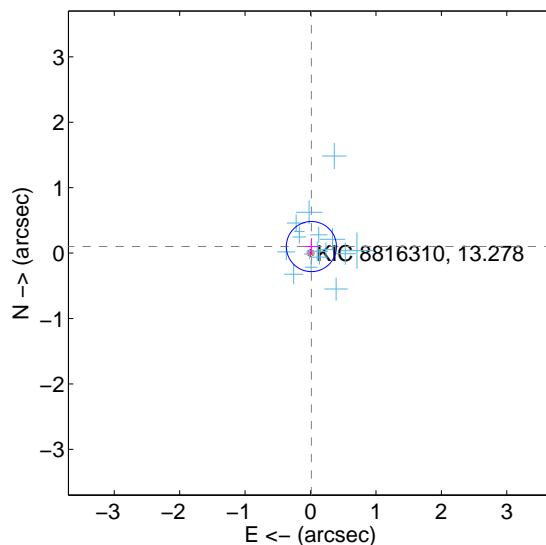
The direct PRF centroid is offset from the target star catalog position by about 0.07 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.171 \pm 0.122$	1.41	$-0.010 \pm 0.091$	$0.171 \pm 0.122$
PRF-fit source offset from KIC position	$0.101 \pm 0.128$	0.79	$-0.013 \pm 0.098$	$0.100 \pm 0.128$
photometric centroid source offset	$0.80 \pm 0.76$	1.05	$0.79 \pm 0.76$	$0.11 \pm 0.76$

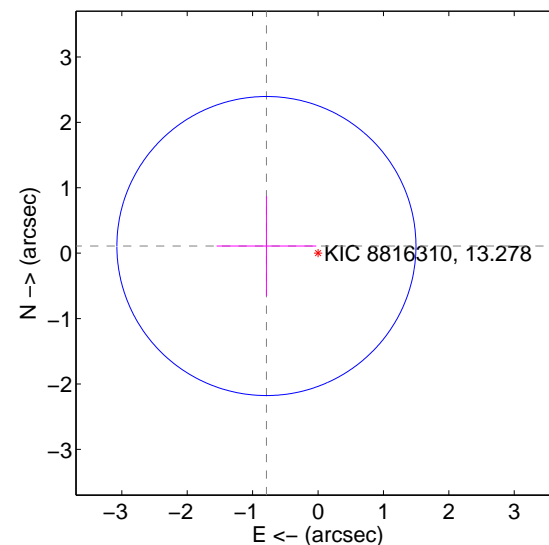
offset from difference PRF-fit to OOT PRF-fit



offset from difference PRF-fit to KIC position

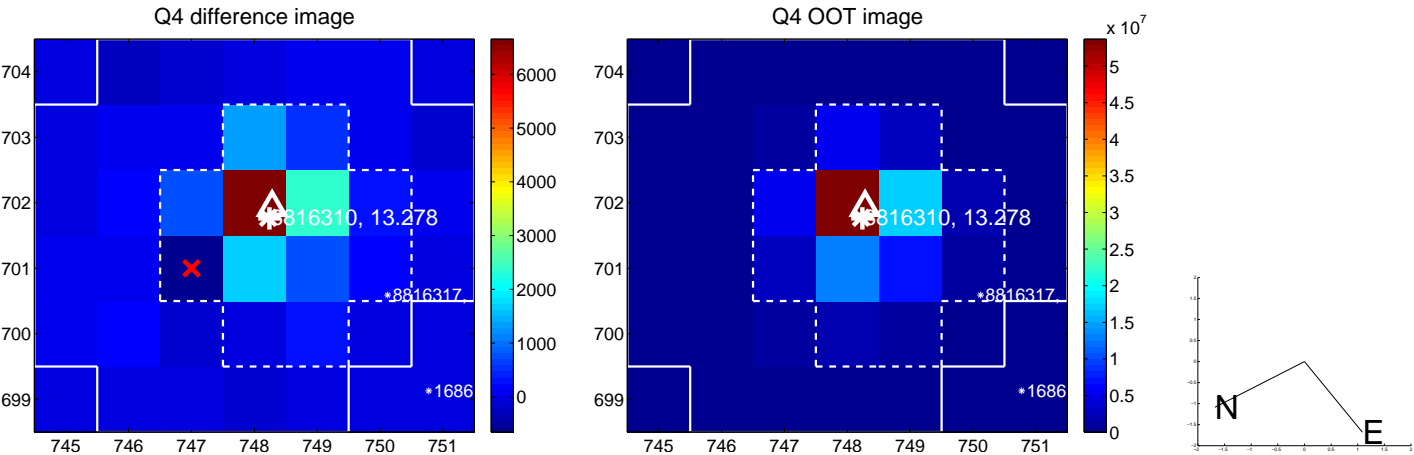
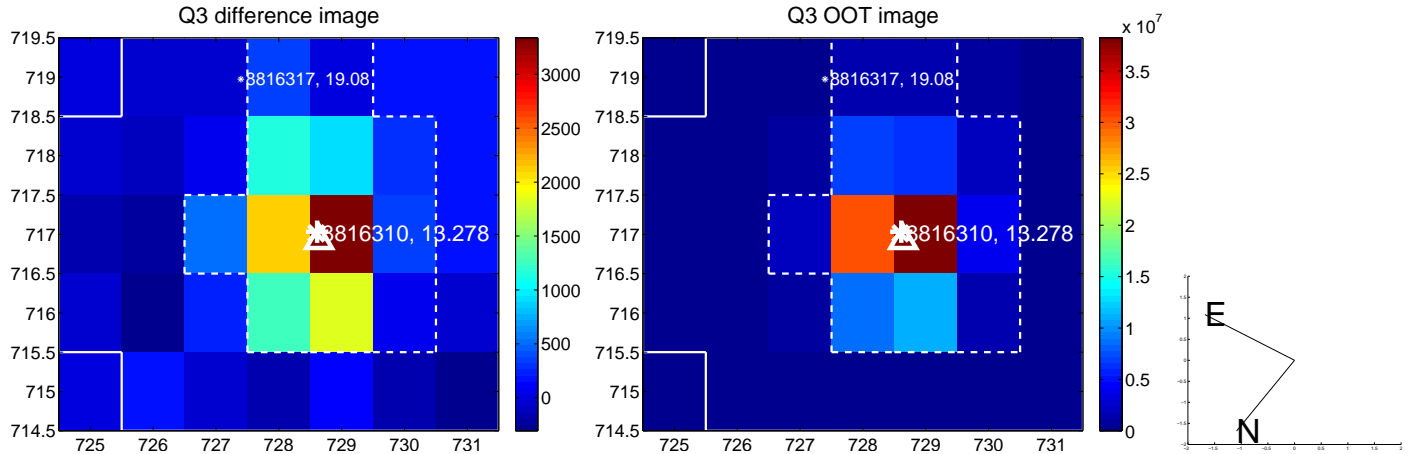
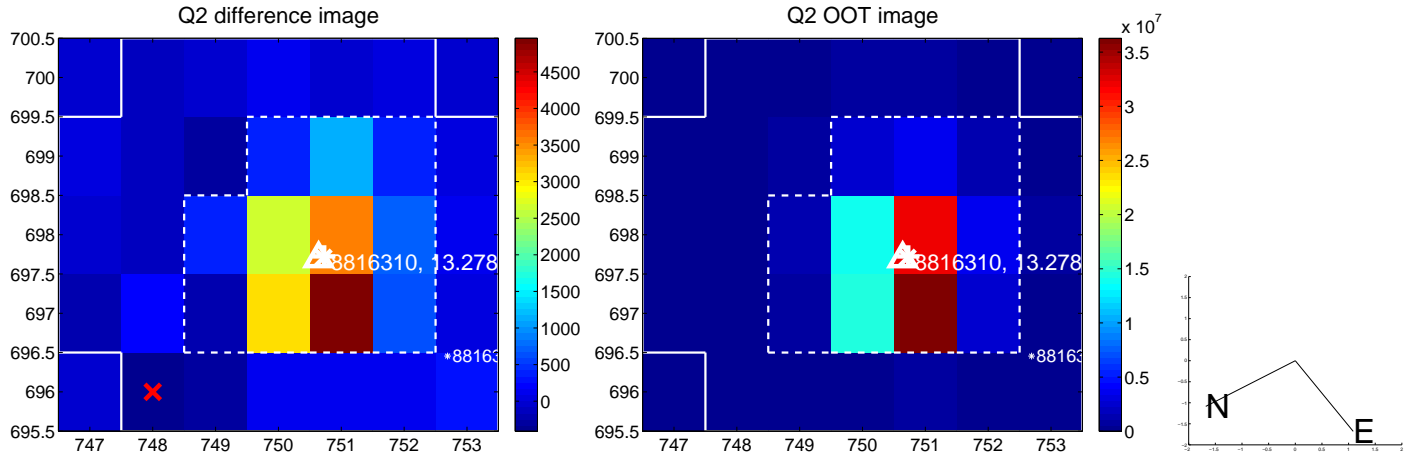
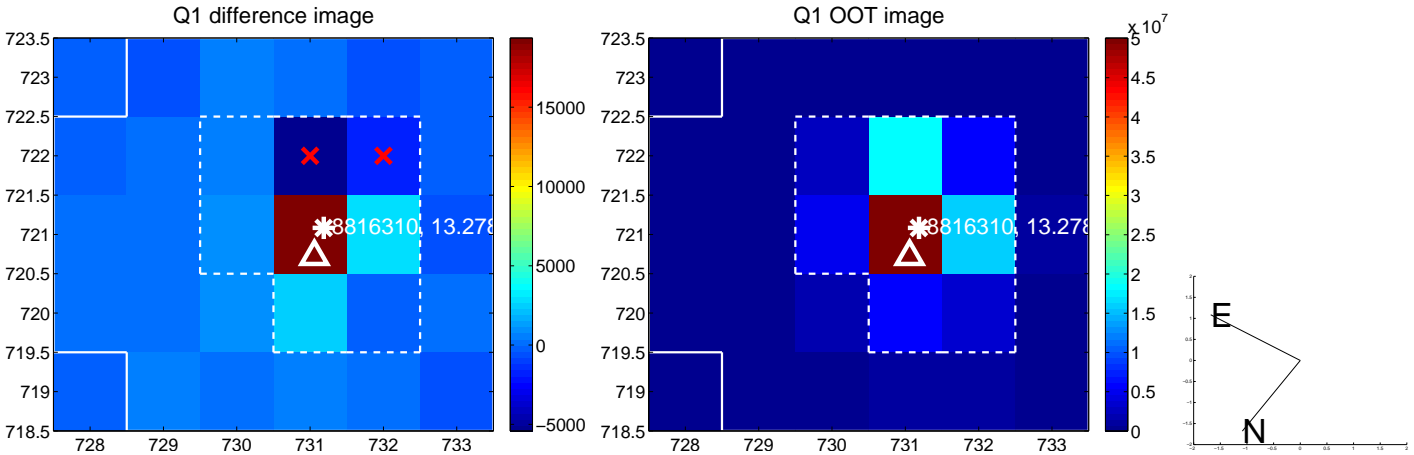


offset from photometric centroids

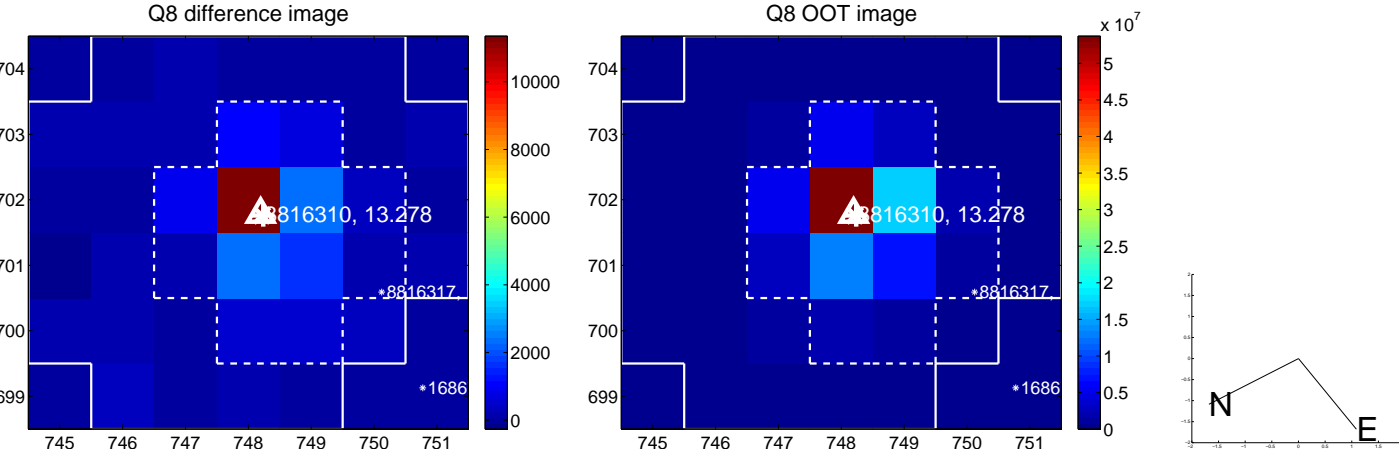
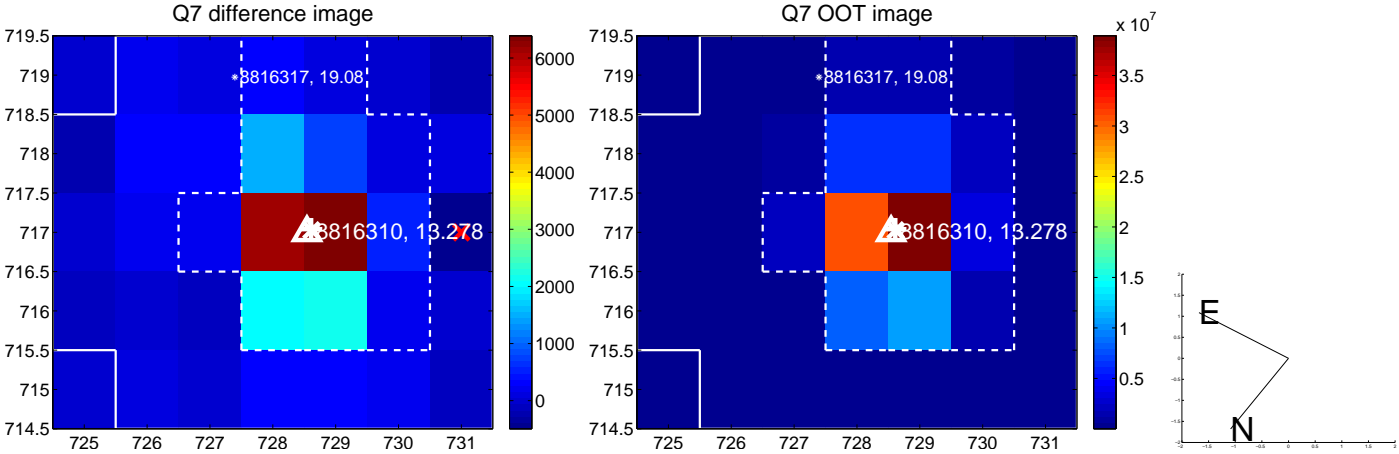
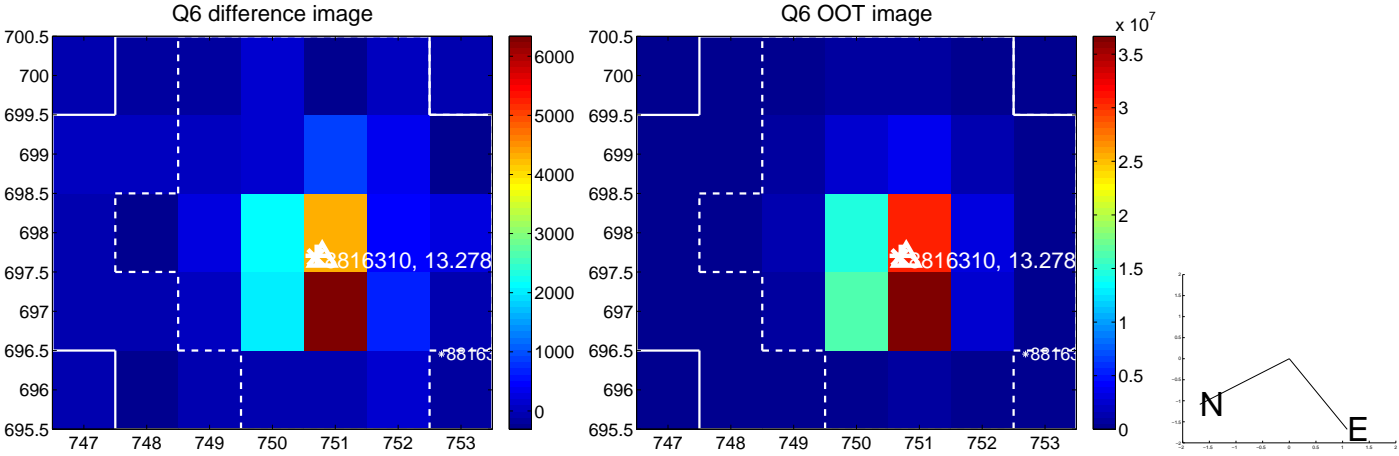
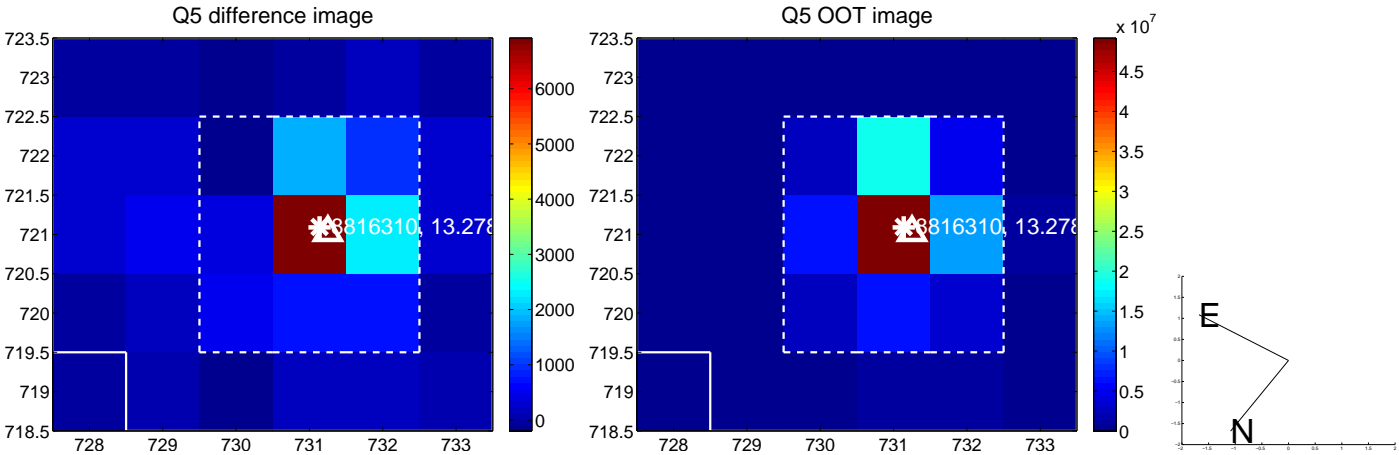


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets**; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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

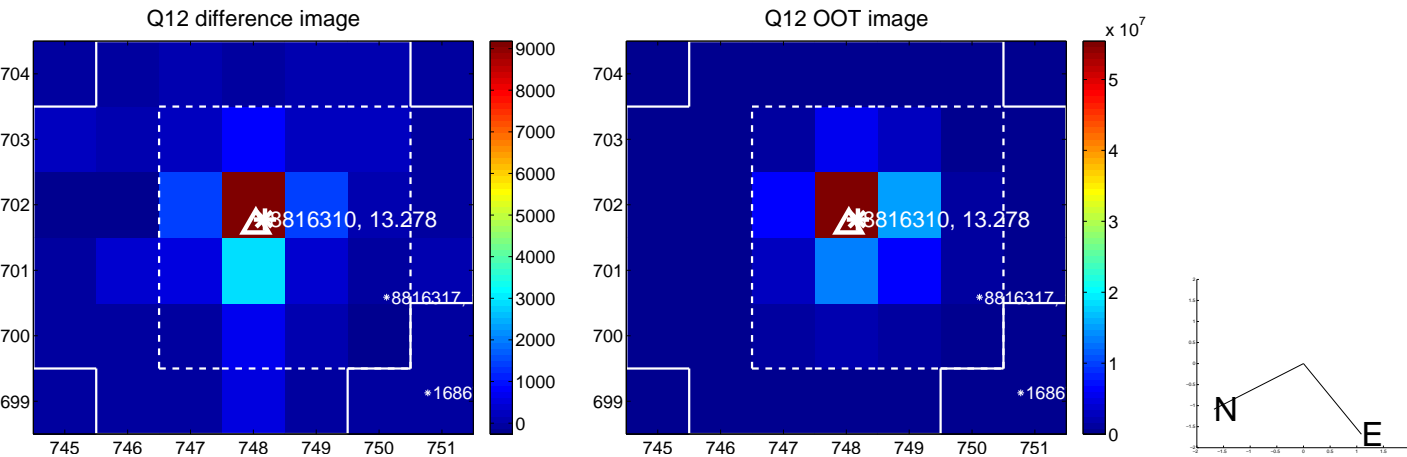
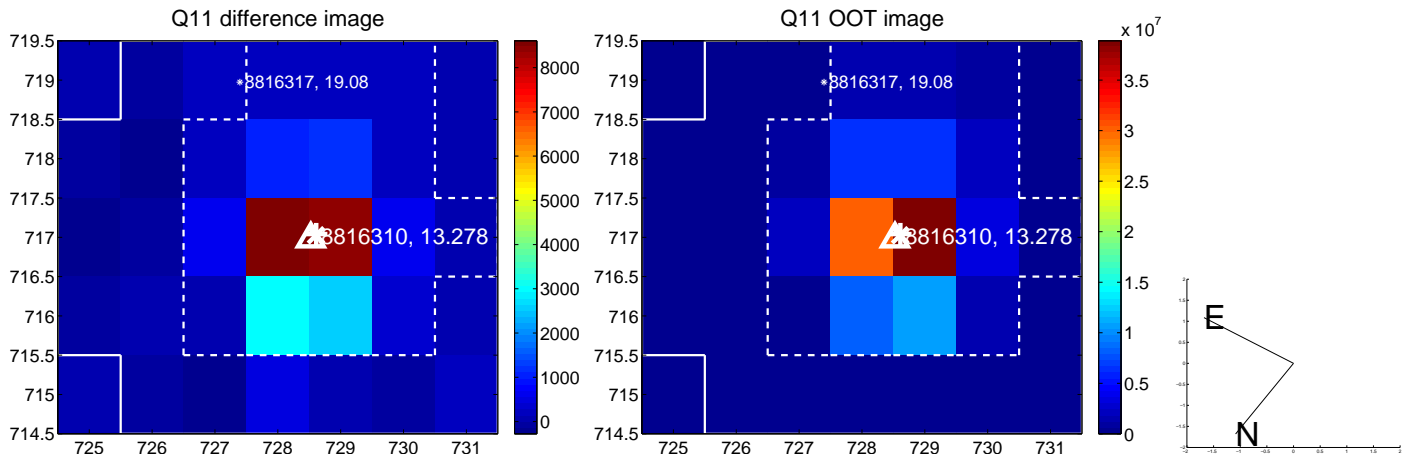
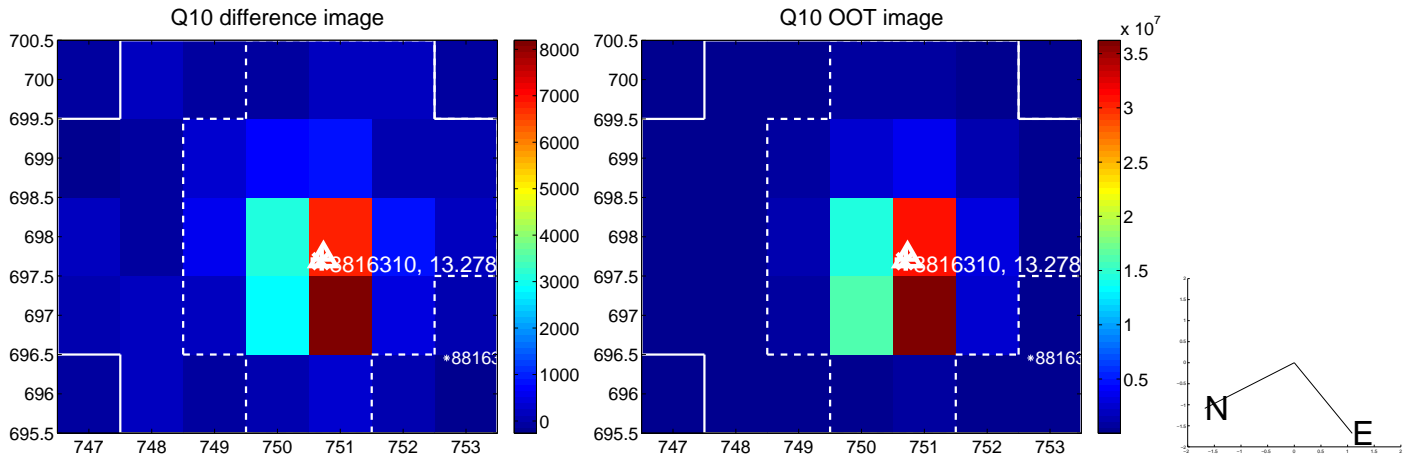
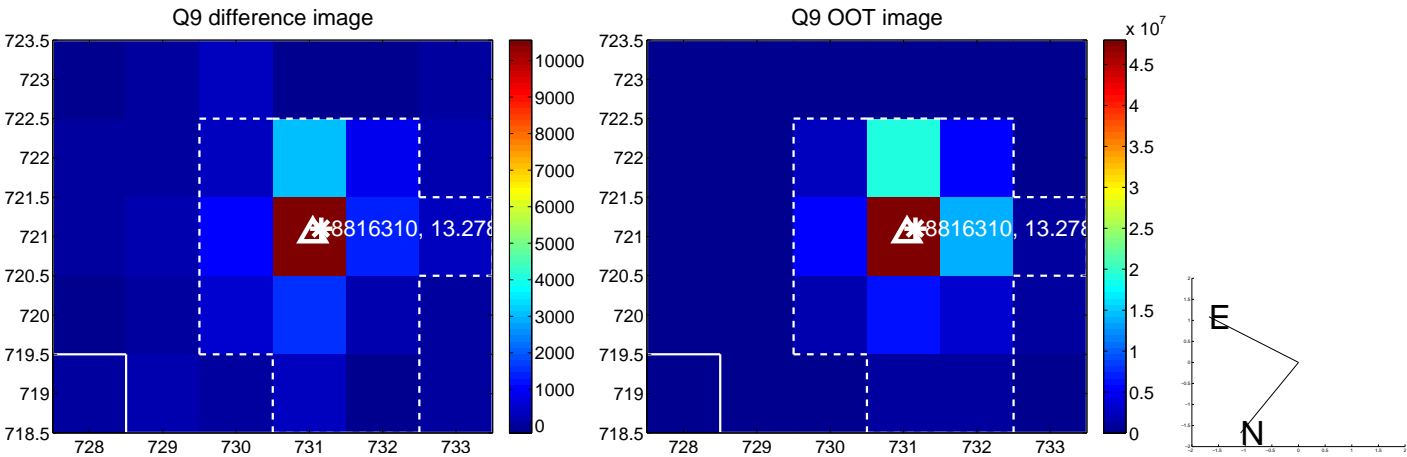
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

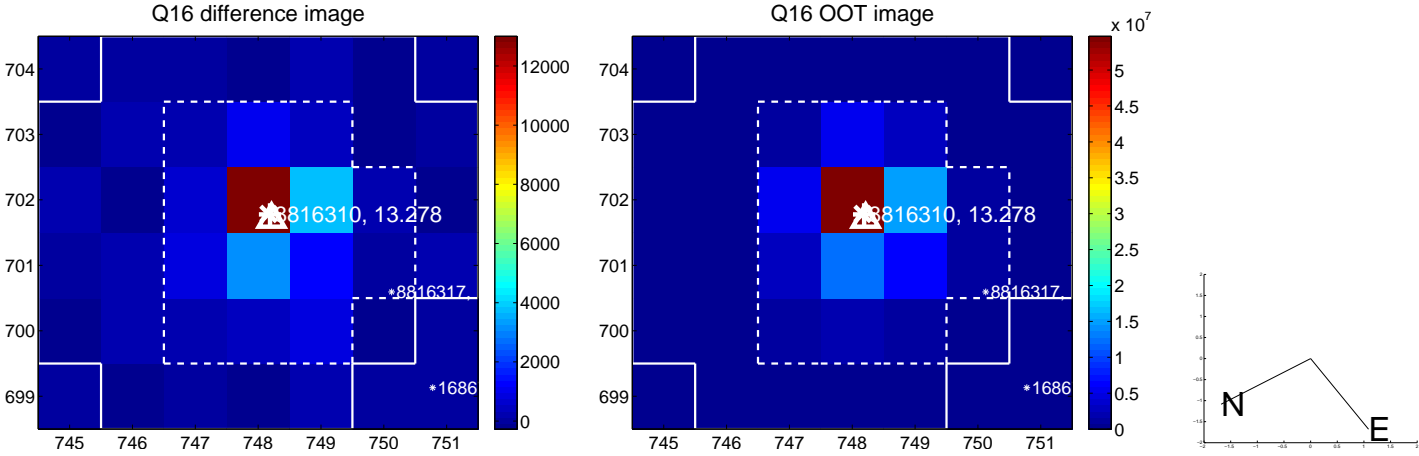
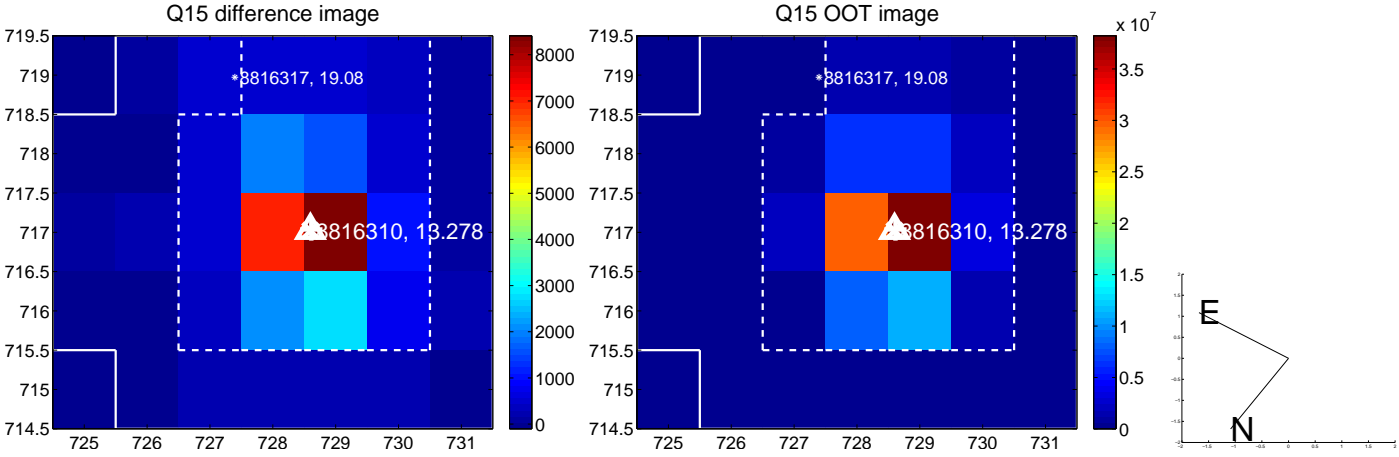
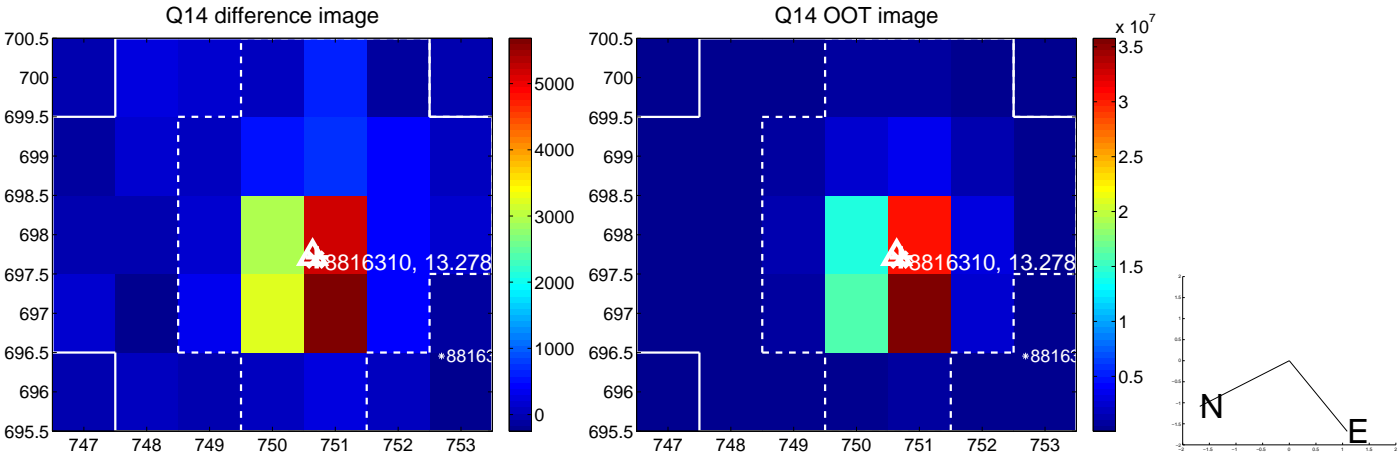
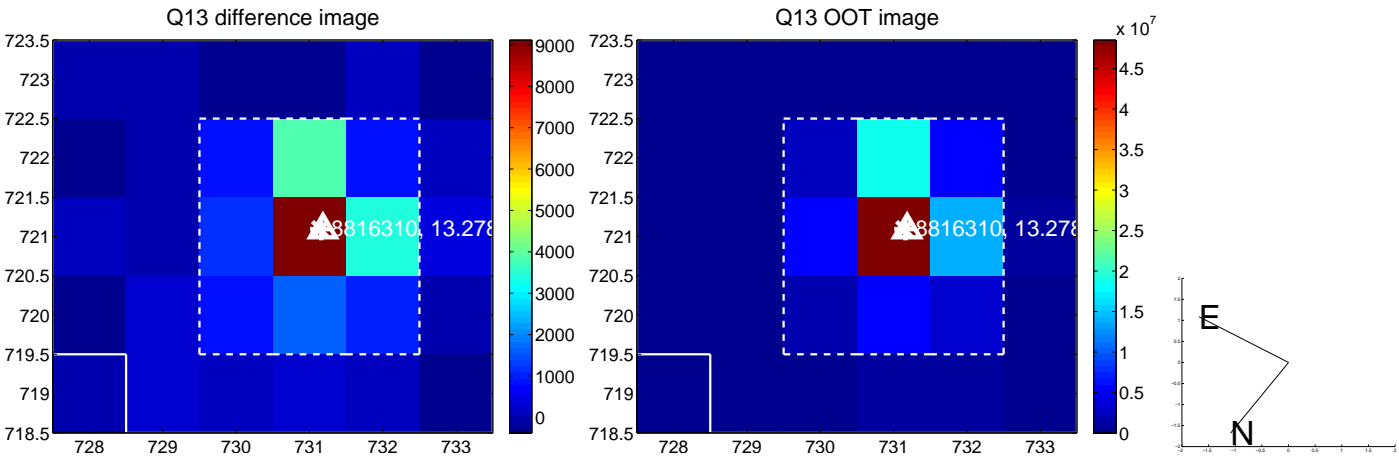


white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

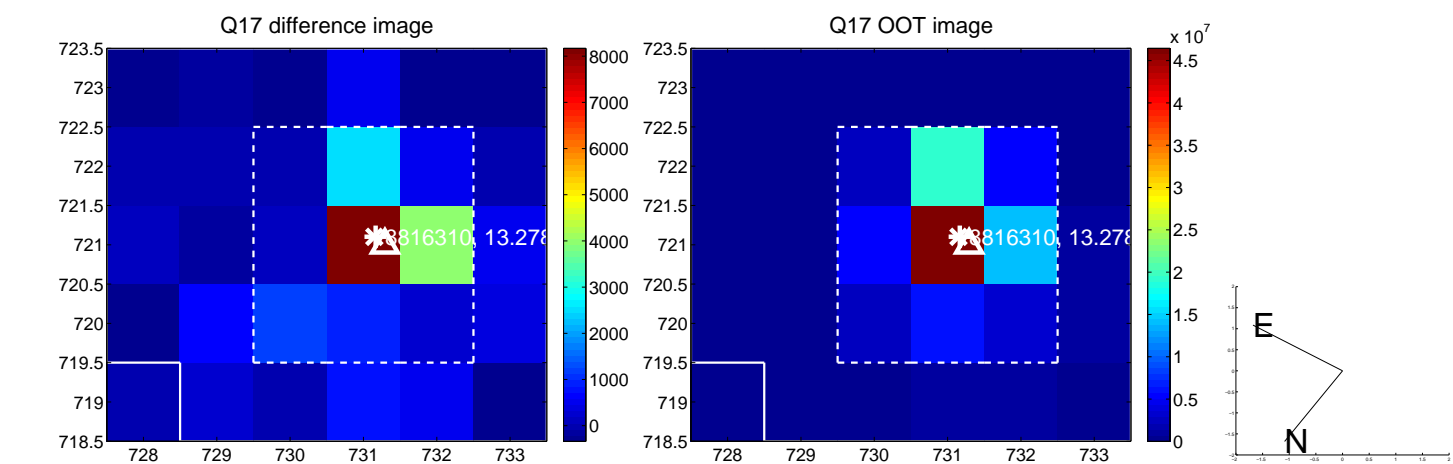




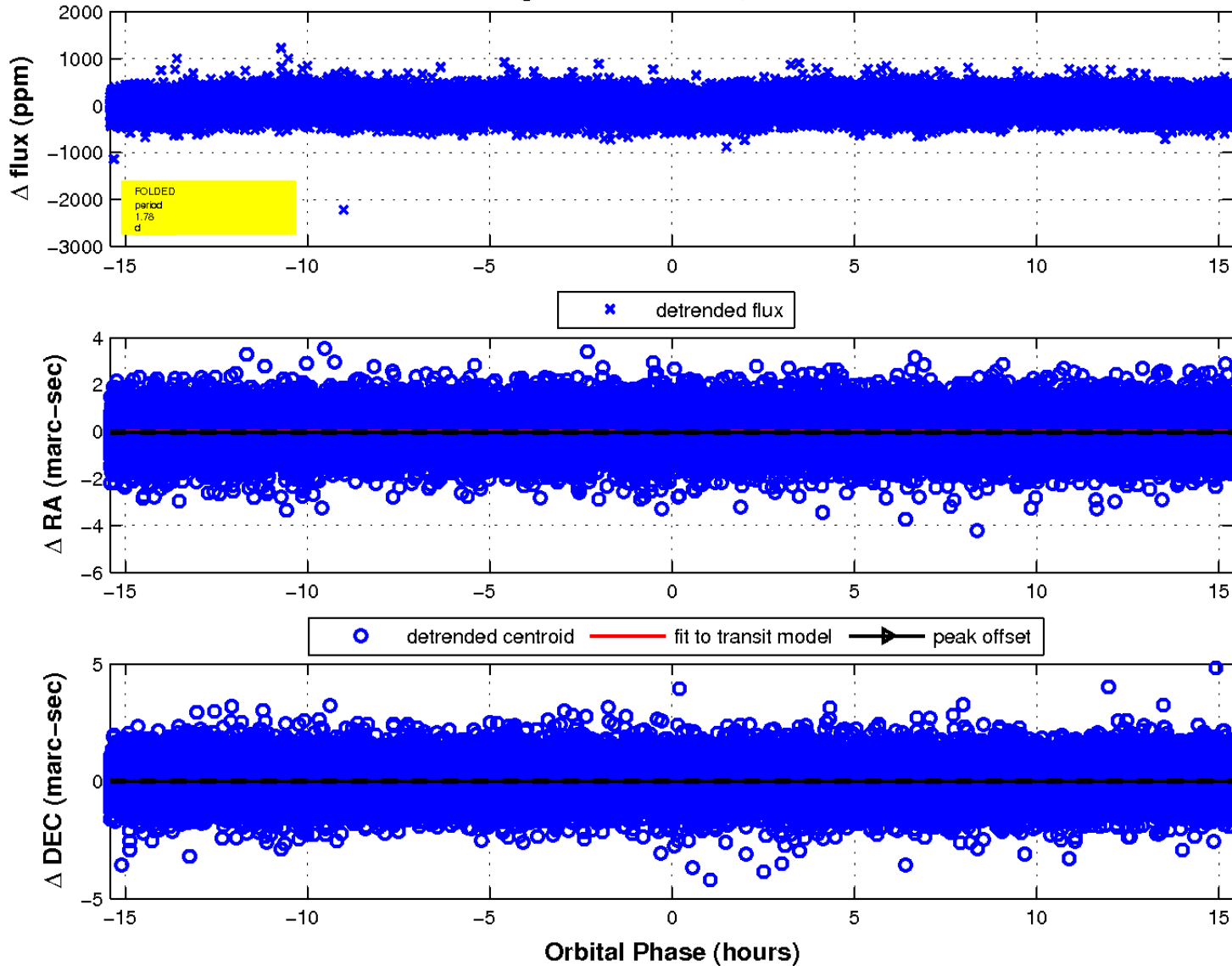
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

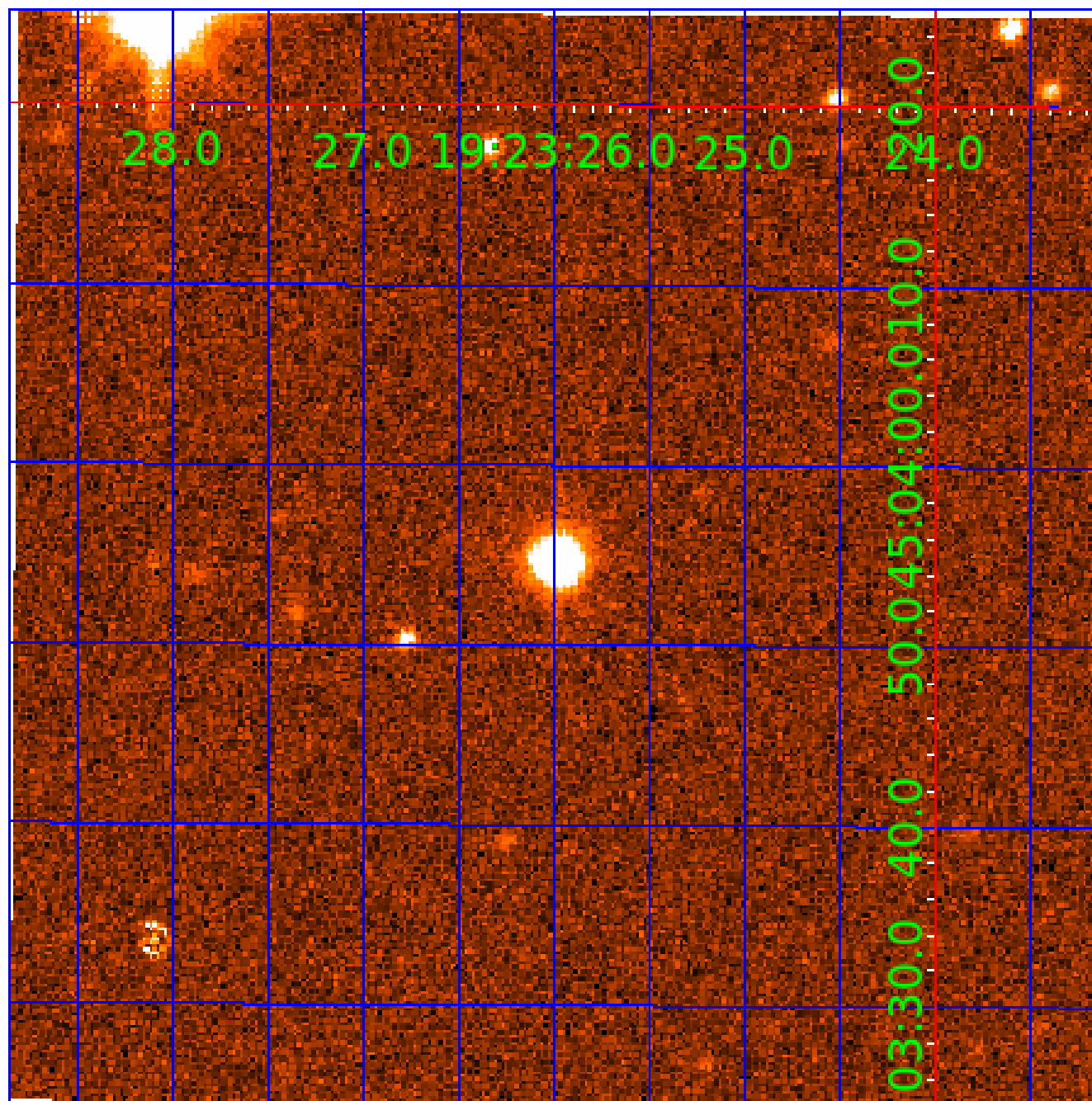


fluxWeightedCentroids, Planet 1 of 4



UKIRT Image

Declination



# KIC 008816310

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
008816310-01	OBS	No	1.778418	133.372527	43.2	5.138	12.5	9.9	1.63	7268	1.82	6466.61
008816310-02	OBS	No	1.778513	132.994912	28.6	13.482	13.7	11.5	1.63	7268	0.89	6466.15
008816310-03	OBS	No	18.408321	149.891981	340.6	1.687	22.4	18.9	1.63	7268	3.32	286.66
008816310-04	OBS	No	20.754171	135.005786	441.9	2.500	12.7	-1.0	1.63	7268	3.49	244.29

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
008816310-01	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_SKYE_ZUMA_TRACKER—LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—MOD_NONUNIQ_ALT
008816310-02	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_SKYE_ZUMA_TRACKER—LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—SAME_NTL_PERIOD
008816310-03	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_SKYE—TRANS_GAPPED—LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—MOD_NONUNIQ_ALT
008816310-04	OBS	FP	0.00	1	0	1	0	INDIV_TRANS_RUBBLE—TRANS_GAPPED—LPP_DV—LPP_ALT—MOD_NONUNIQ_ALT—MOD_TER_ALT—MOD_POS_ALT—CENT_NOFITS—HALO_GHOST

**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.

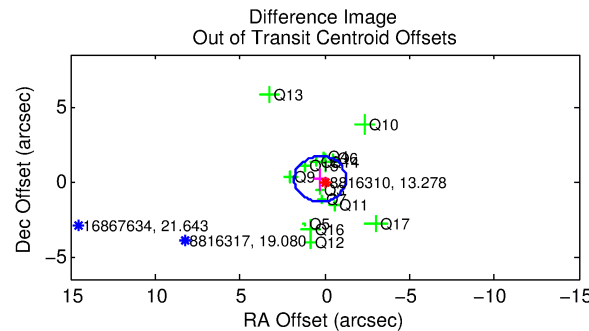
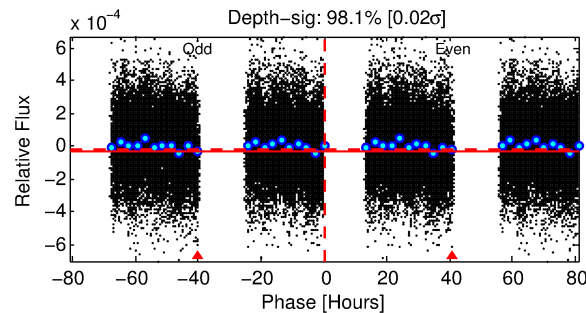
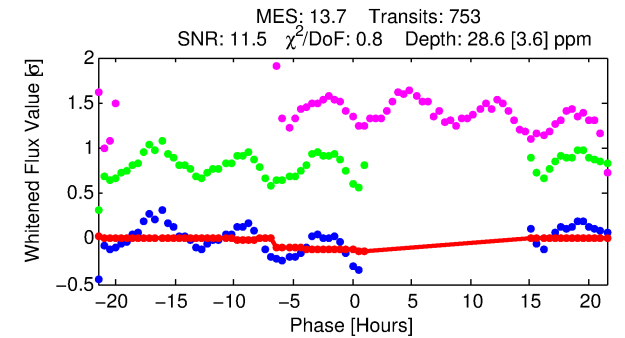
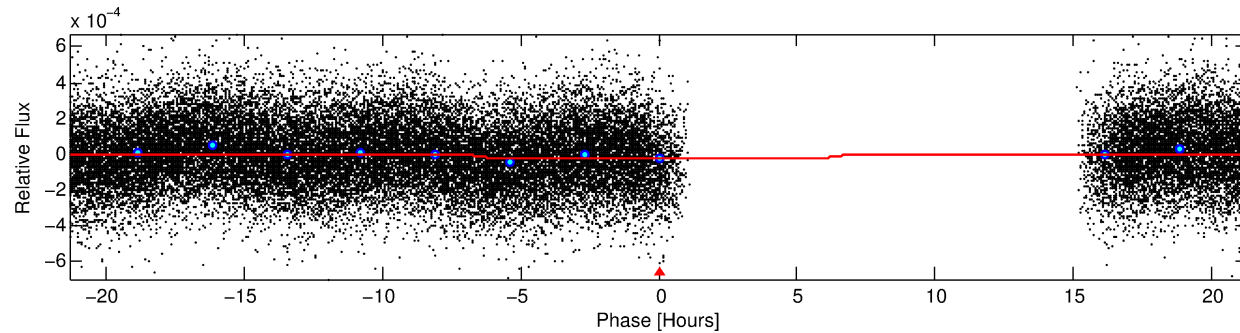
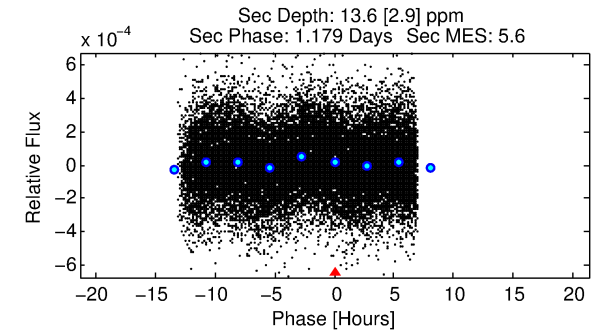
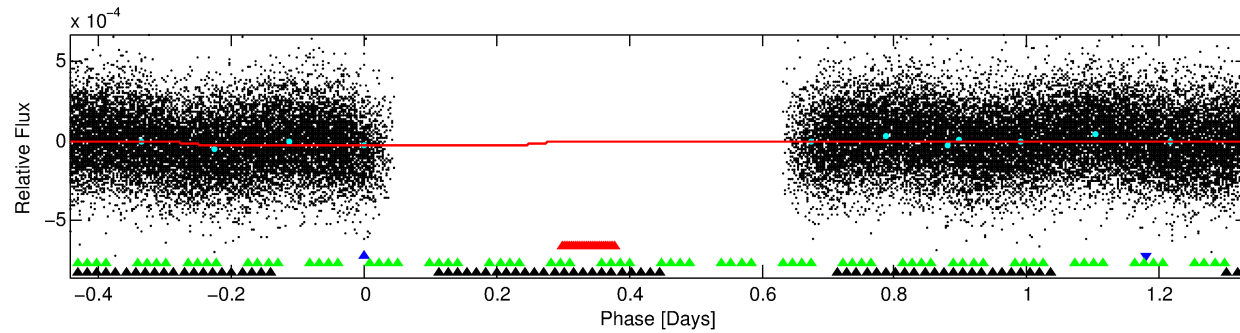
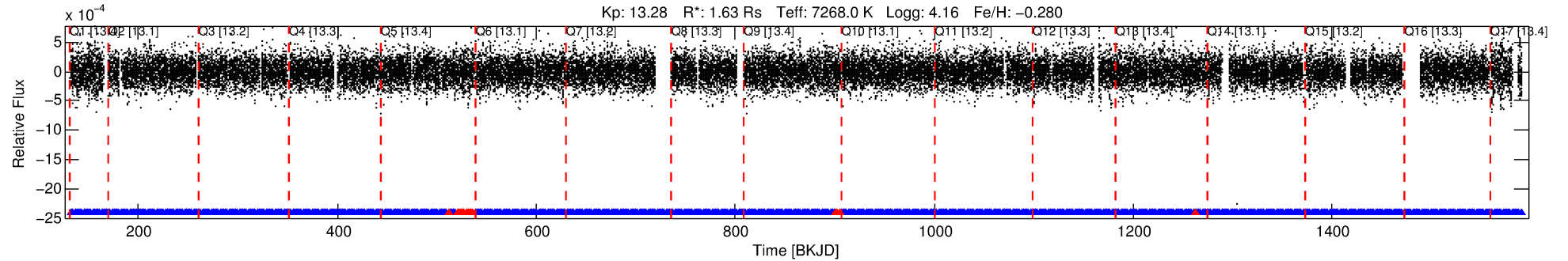
Ephemeris Match Information For 008816310-02

No Significant Match Found



# DV One-Page Summary

KIC: 8816310 Candidate: 2 of 4 Period: 1.779 d



## DV Fit Results:

Period = 1.77851 [0.00004] d  
Epoch = 132.9949 [0.0241] BKJD  
Rp/R\* = 0.0050 [0.0057]  
a/R\* = 1.20 [2.51]  
b = 0.05 [125.18]  
Seff = 6466.15 [2507.46]  
Teq = 2287 [222] K  
Rp = 0.89 [1.06] Re  
a = 0.0321 [0.0082] AU  
Ag = 9.84 [22.97] [0.38σ]  
Teffp = 6261 [3622] K [1.10σ]

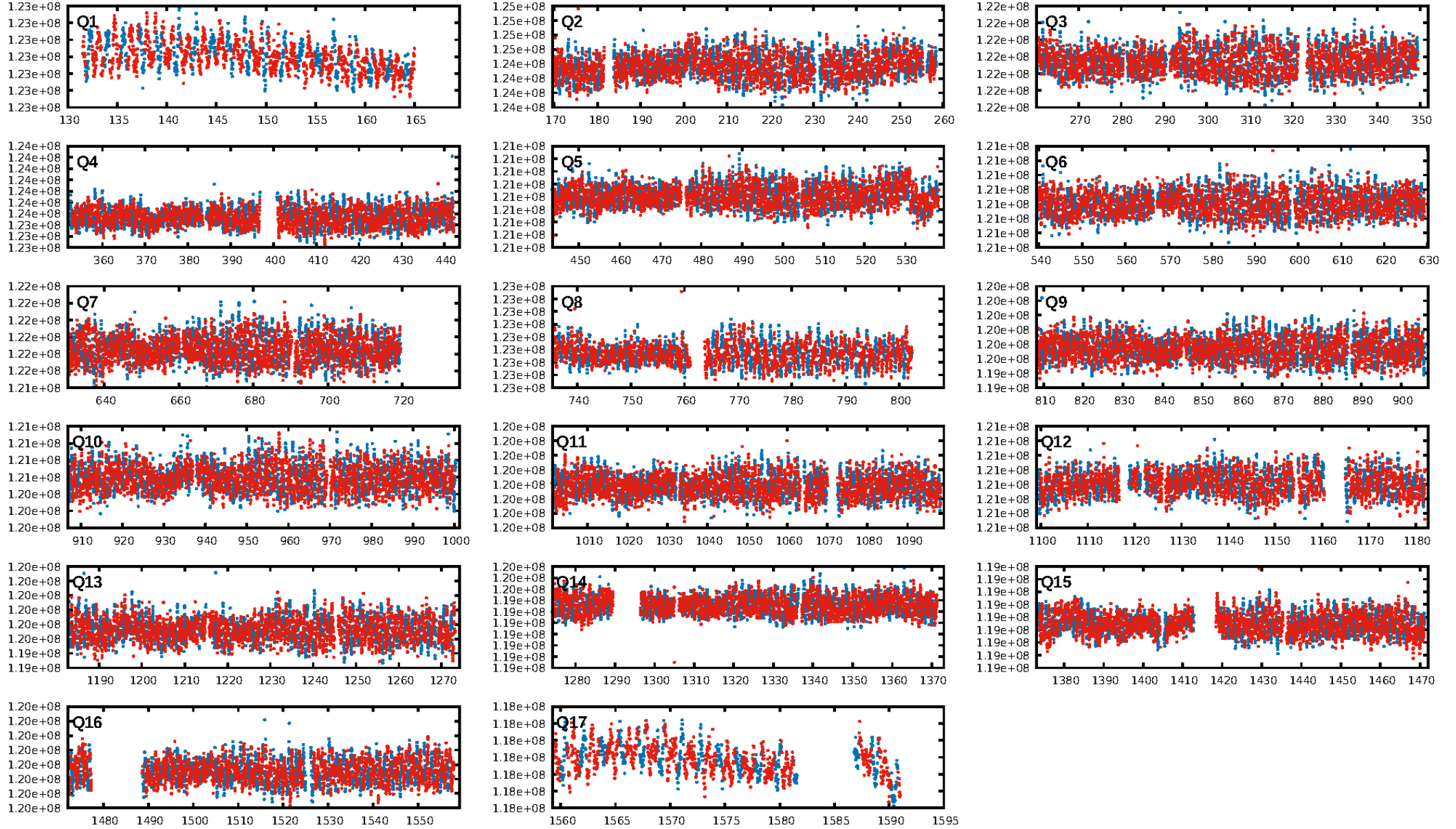
## DV Diagnostic Results:

ShortPeriod-sig: 0.0% [0.00σ]  
LongPeriod-sig: 100.0% [29.38σ]  
ModelChiSquare2-sig: N/A  
ModelChiSquareGof-sig: N/A  
Bootstrap-pfa: 1.16e-164  
RollingBand-fgt: 0.98 [704/719]  
GhostDiagnostic-chr: 5.846  
Centroid-sig: 81.3%  
Centroid-so: 0.252 arcsec [0.44σ]  
OotOffset-rm: 0.317 arcsec [0.62σ]  
OotOffset-st: 3/4/4/4 [15]  
KicOffset-rm: 0.305 arcsec [0.66σ]  
KicOffset-st: 3/4/4/4 [15]  
DiffImageQuality-fgm: 0.53 [8/15]  
DiffImageOverlap-fno: 0.00 [0/17]

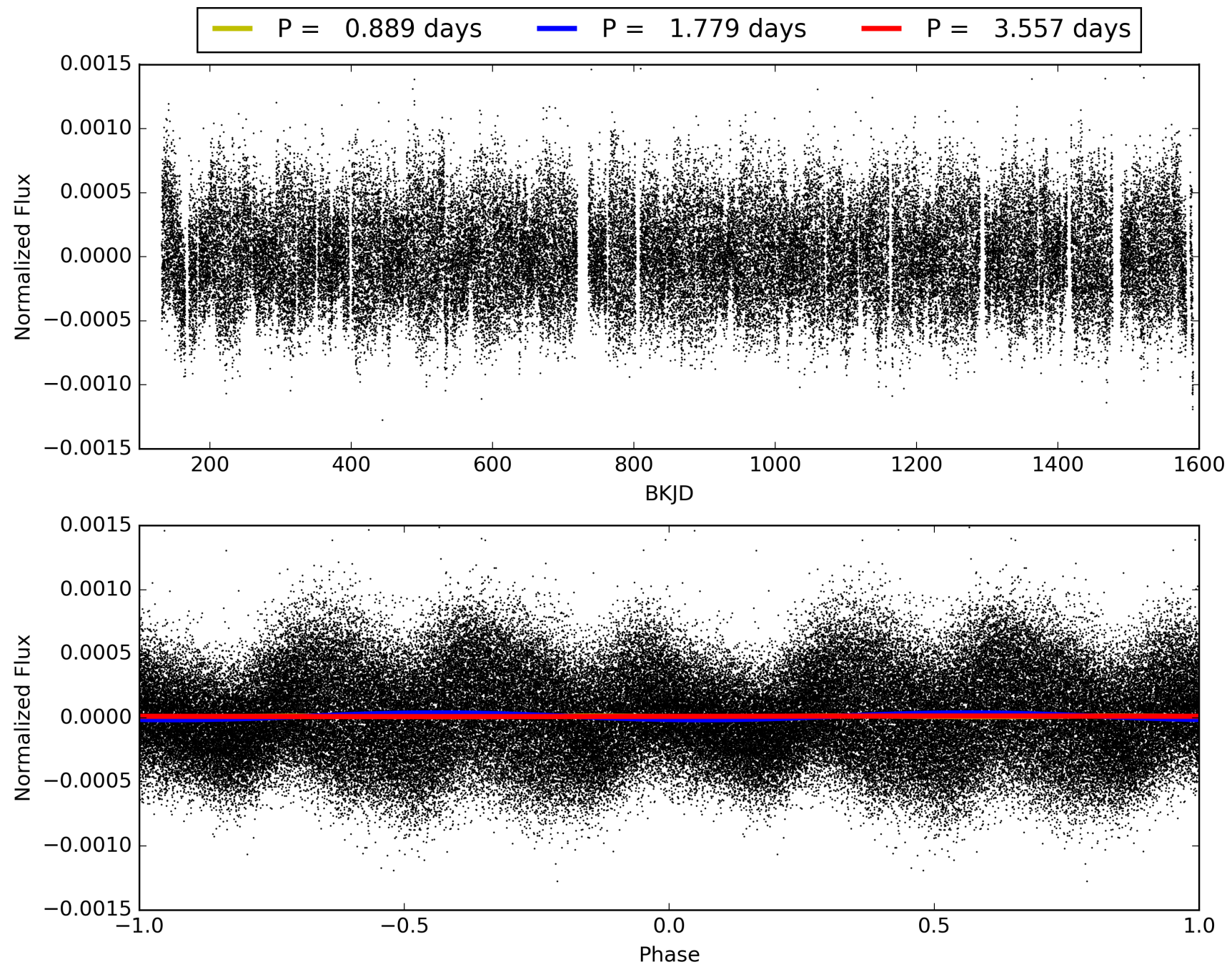
Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 31-Jan-2016 19:06:02 Z

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

# TCE 008816310-02, PDC Light Curves

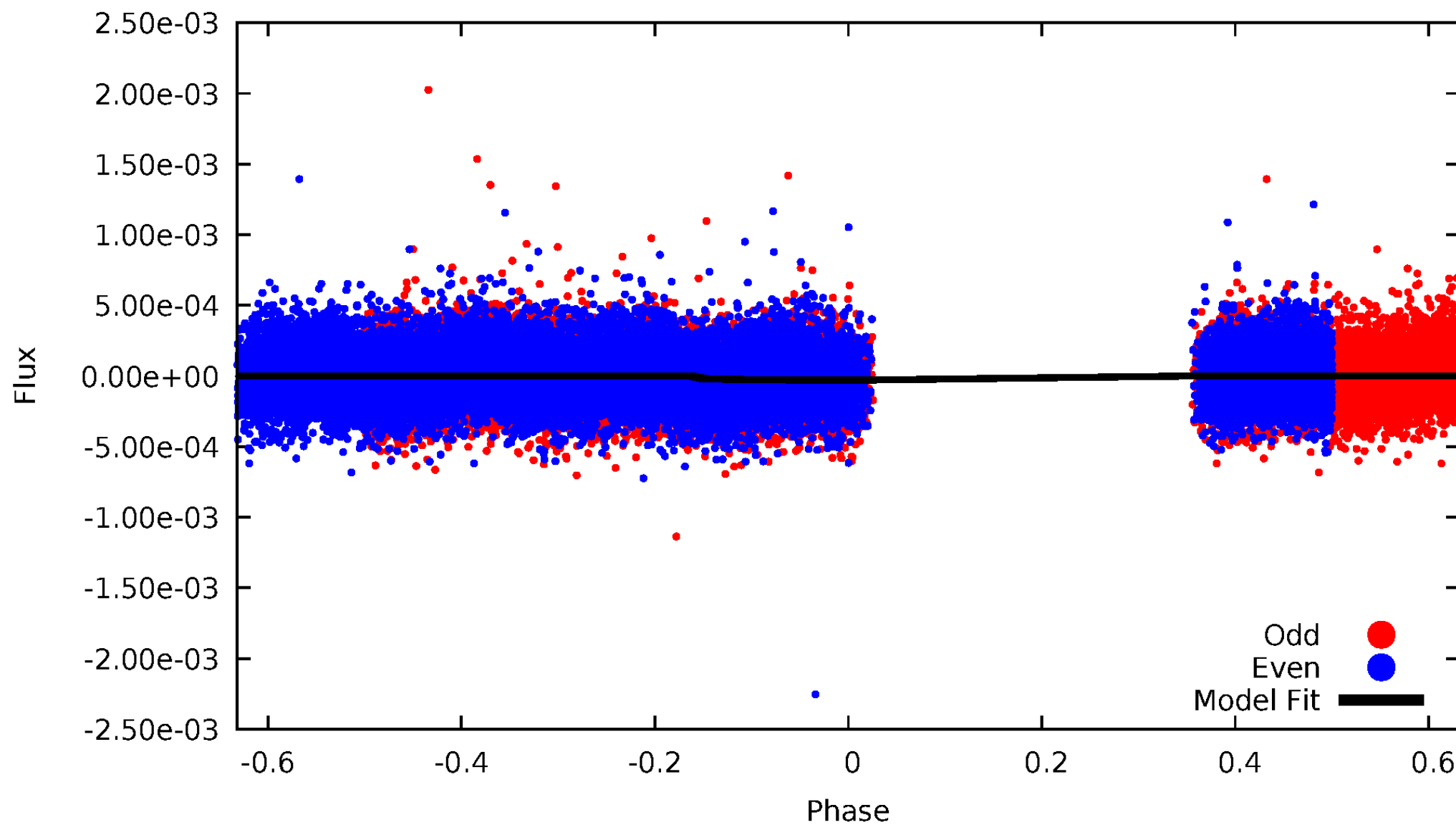


# TCE 008816310-02



DV Odd/Even

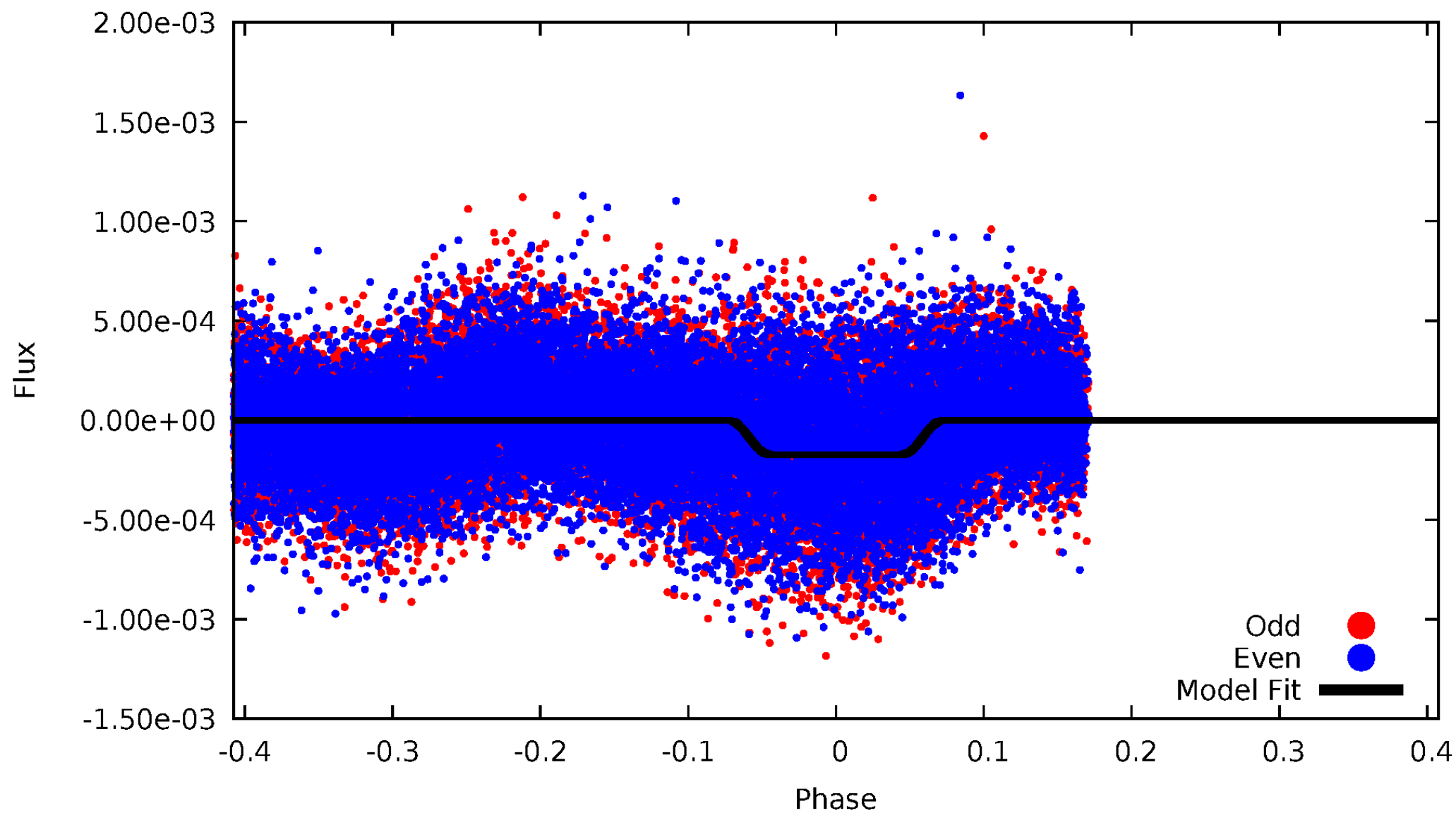
TCE 008816310-02





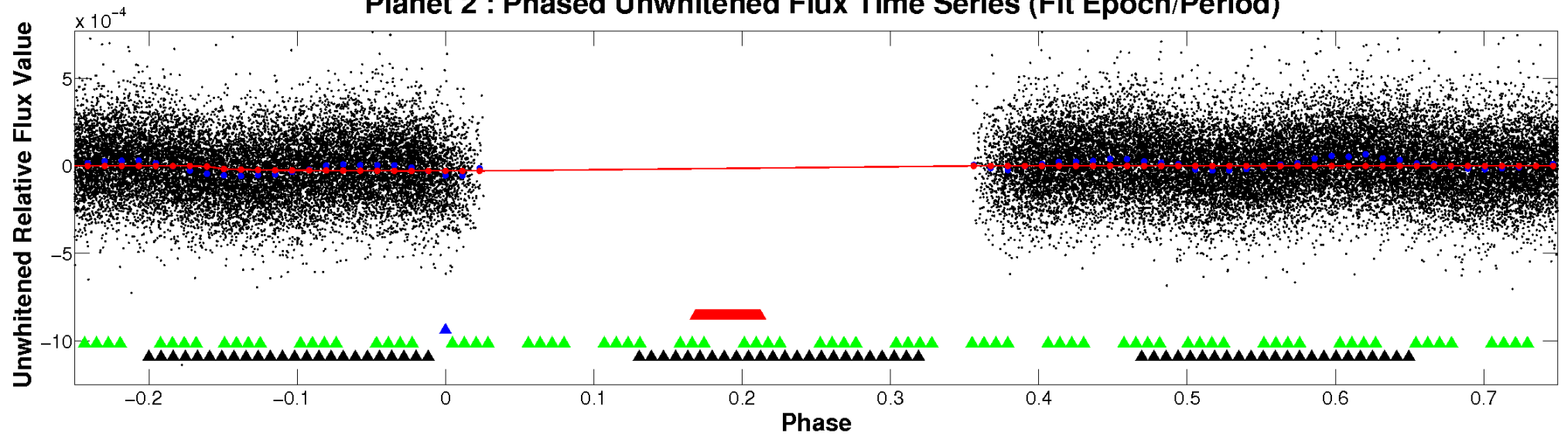
# ALT Odd/Even

TCE 008816310-02

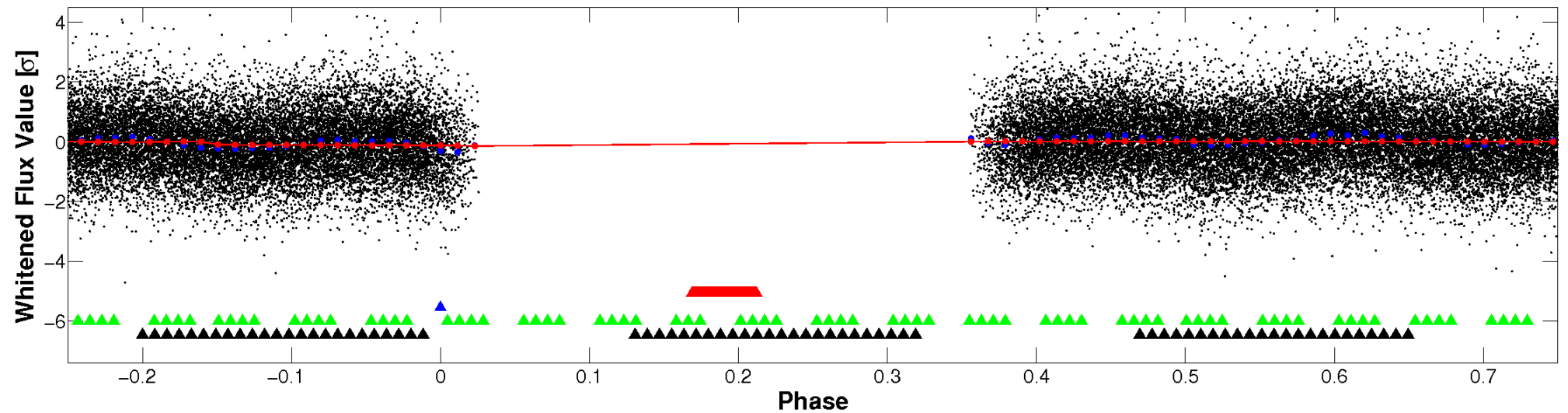


# Non-Whitened Vs. Whitened Light Curve

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

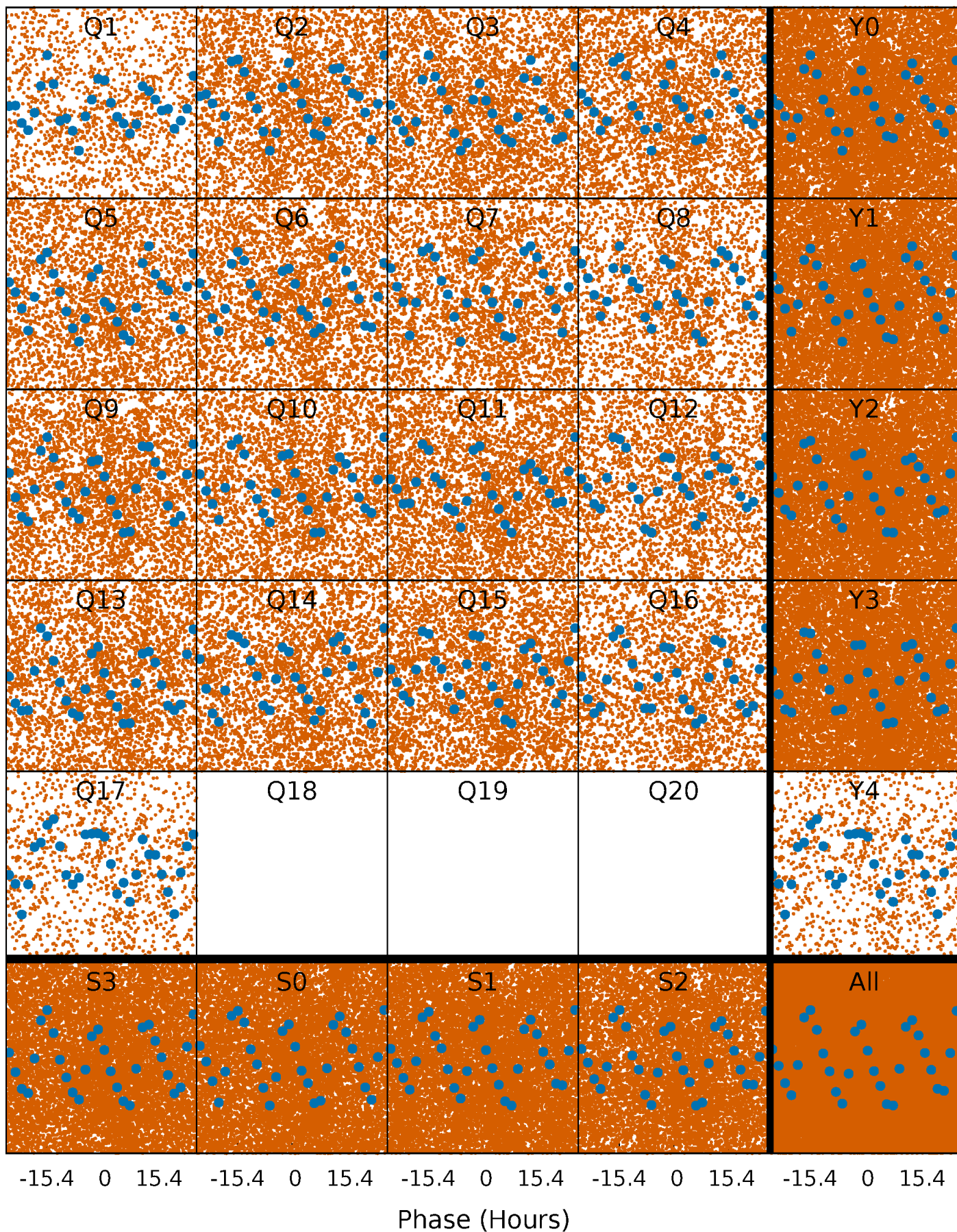


## Planet 2 : Phased Whitened Flux Time Series (Fit Epoch/Period)



# PDC Quarter-Phased Transit Curves

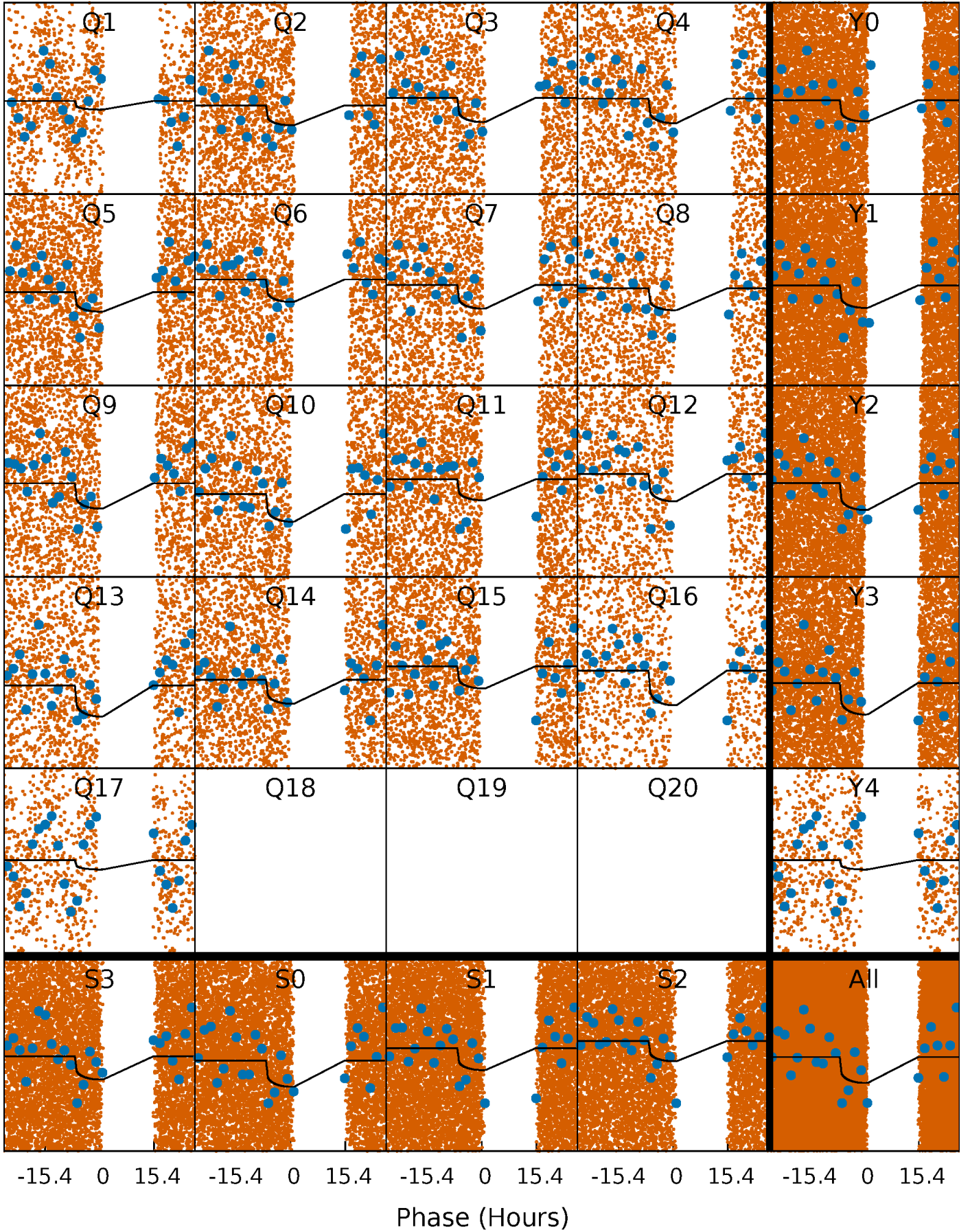
TCE 008816310-02 P= 1.778513 Days  $T_0=132.994912$  (BKJD)





# DV Quarter-Phased Transit Curves

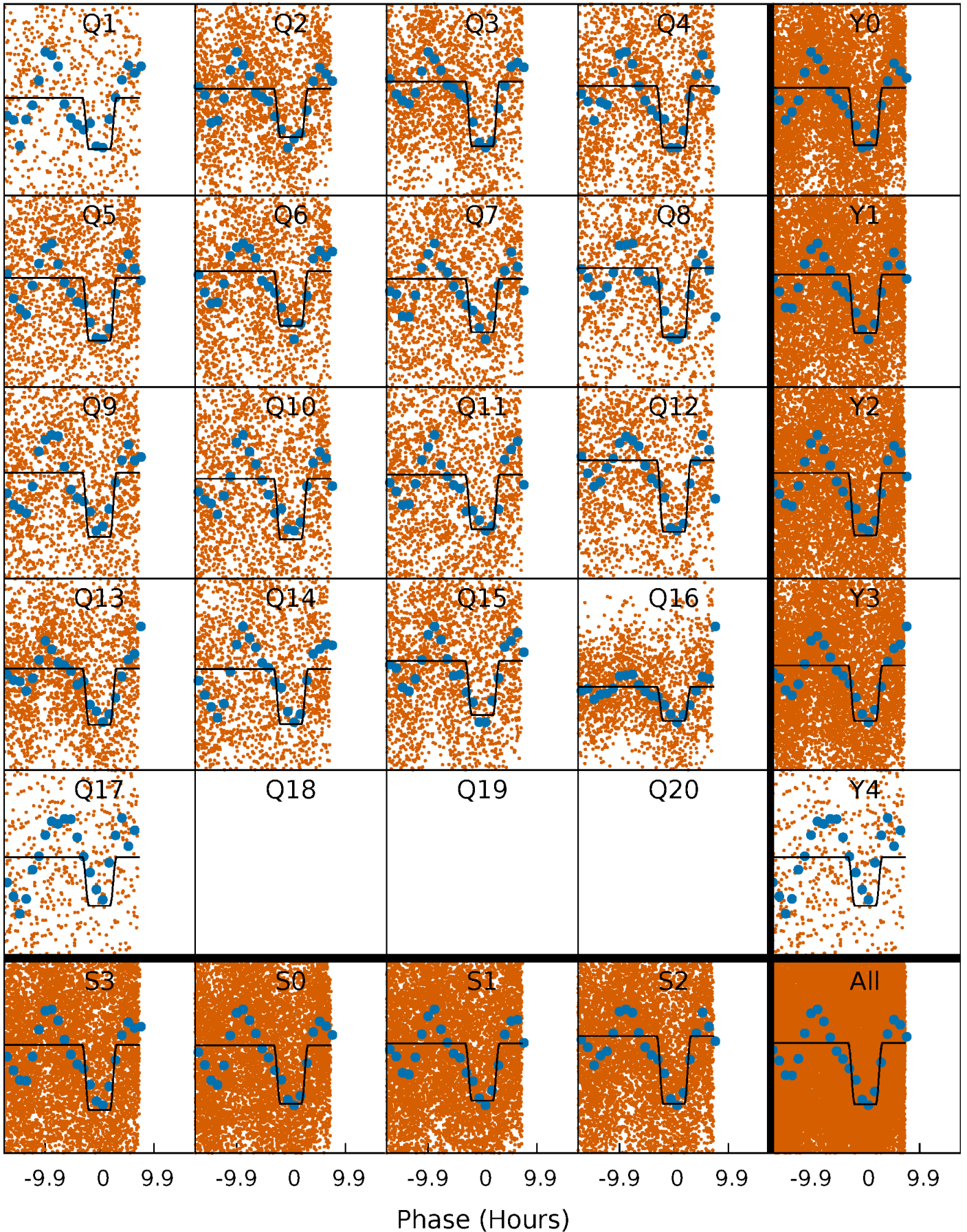
TCE 008816310-02   P= 1.778513 Days    $T_0=132.994912$  (BKJD)





# Alt. Detrend Quarter-Phased Transit Curves

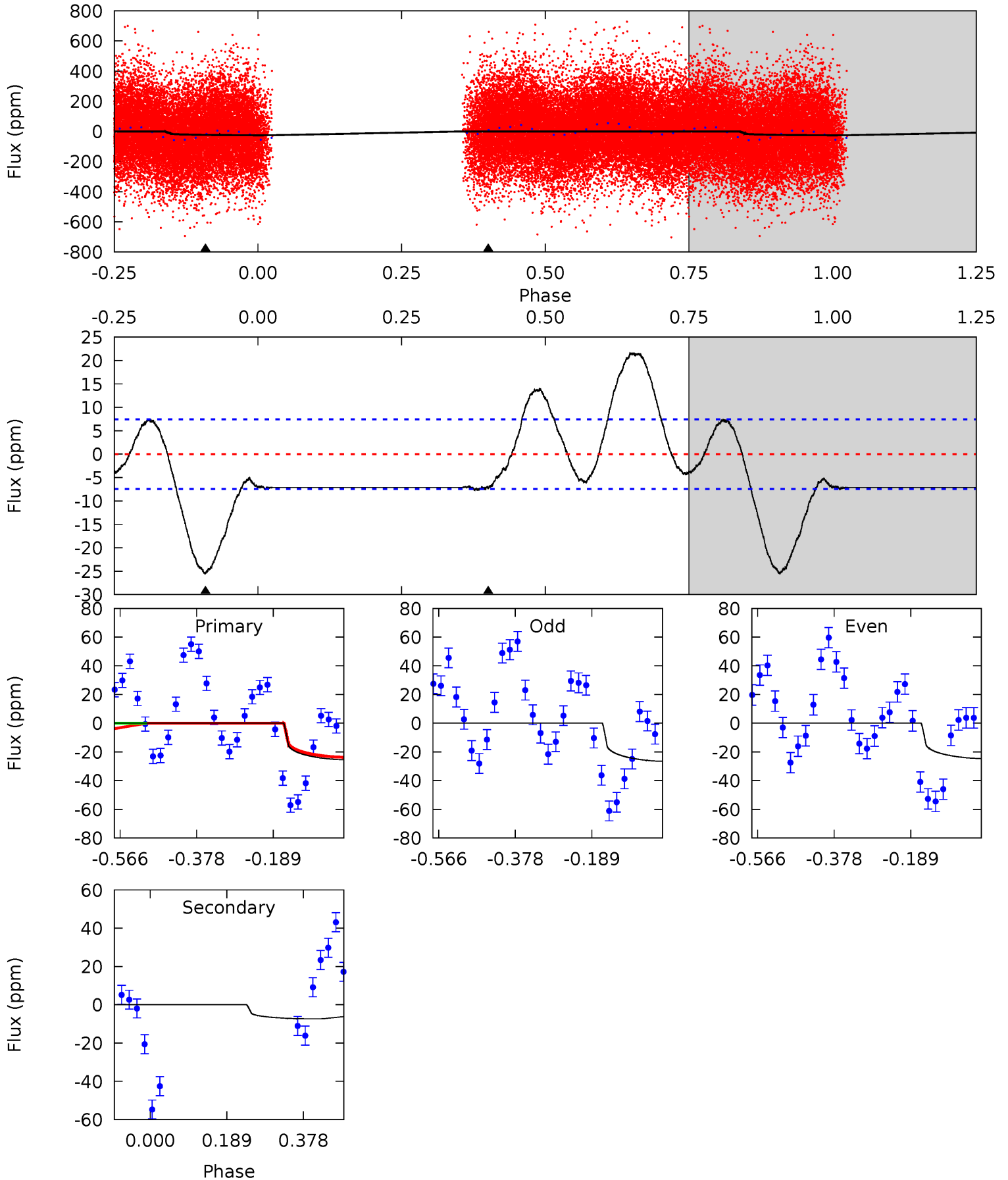
TCE 008816310-02   P= 1.778434 Days    $T_0=132.736486$  (BKJD)



# DV Model-Shift Uniqueness Test

008816310-02, P = 1.778513 Days, E = 131.216399 Days

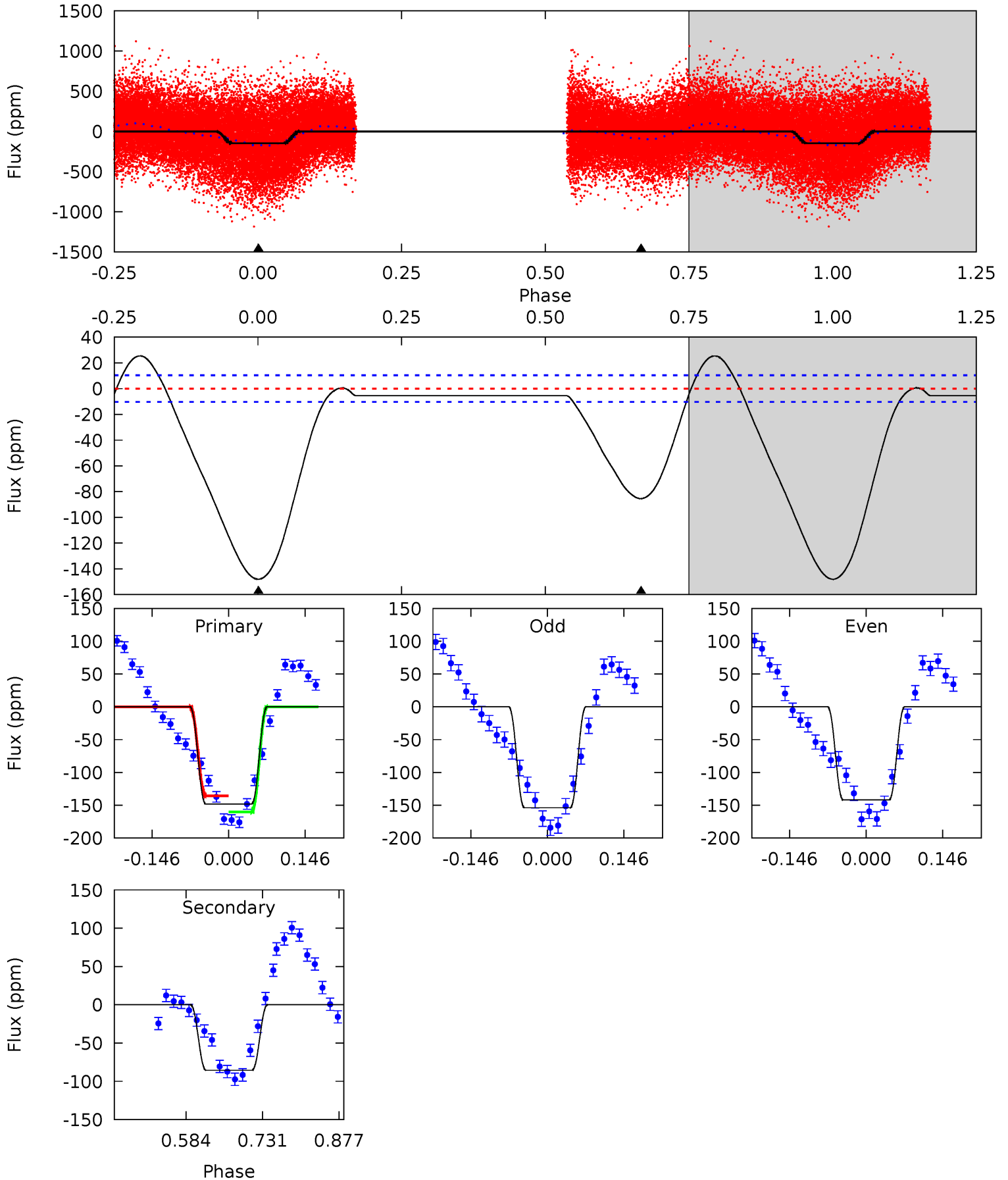
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
15.2	4.39	0	0	4.43	1.31	4.71	15.2	15.2	4.39	4.39	0.57	1.02	0.46	3.83



# Alt Model-Shift Uniqueness Test

008816310-02, P = 1.778434 Days, E = 130.958052 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
64.2	37.1	0	0	4.48	1.45	4.00	64.2	64.2	37.1	37.1	2.54	1.05	0.15	5.19



### Stellar Parameters For KIC 008816310

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R$ ( $R_{\odot}$ )	$M$ ( $M_{\odot}$ )	$p_{\star}$ ( $\text{g}\cdot\text{cm}^{-3}$ )
	$7268^{+228}_{-304}$	$4.157^{+0.148}_{-0.181}$	$-0.280^{+0.250}_{-0.350}$	$1.634^{+0.521}_{-0.347}$	$1.399^{+0.204}_{-0.226}$	$0.451^{+0.387}_{-0.220}$
	+3%/-4%	+4%/-4%	+89%/-125%	+32%/-21%	+15%/-16%	+86%/-49%
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 008816310-02 / KOI

Detrend	Depth (ppm)	$R_p$ ( $R_{\oplus}$ )	$T_{max}$ (K)	$T_{obs}$ (K)	$A_{obs}$
DV	$-7 \pm 2$	$1.14^{+0.89}_{-0.74}$	$3198^{+256}_{-209}$	$4697^{+3449}_{-1107}$	$3.137^{+21.879}_{-2.191}$
Alt.	$-85 \pm 2$	$2.39^{+1.18}_{-1.04}$	$3211^{+257}_{-217}$	$5923^{+2271}_{-937}$	$8.404^{+19.117}_{-4.550}$

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

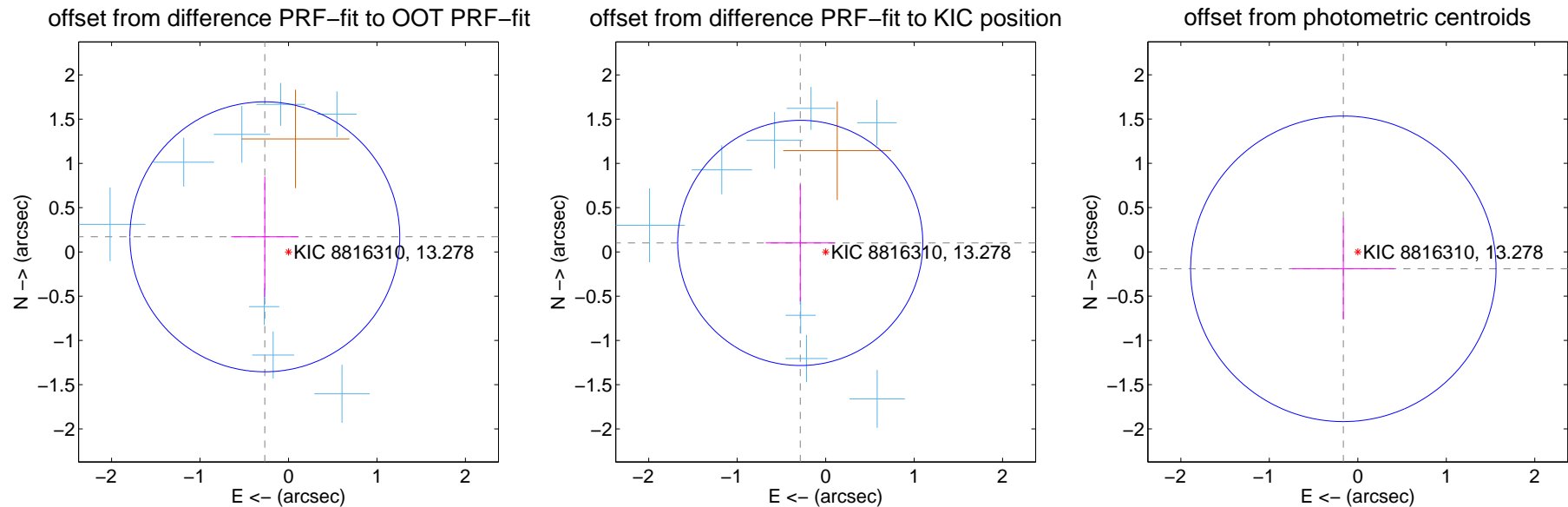
## DV Centroid Data

Supplemental centroid analysis for 008816310-02. Kepler magnitude: 13.28. Transit SNR 11.54

There are 8 quarters with good PRF difference image offsets

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

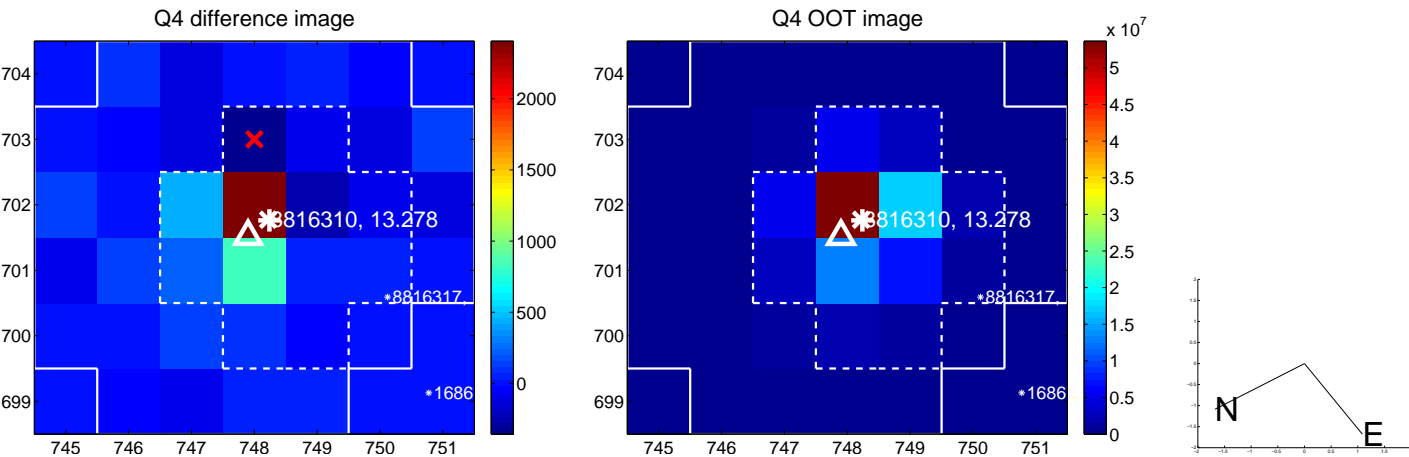
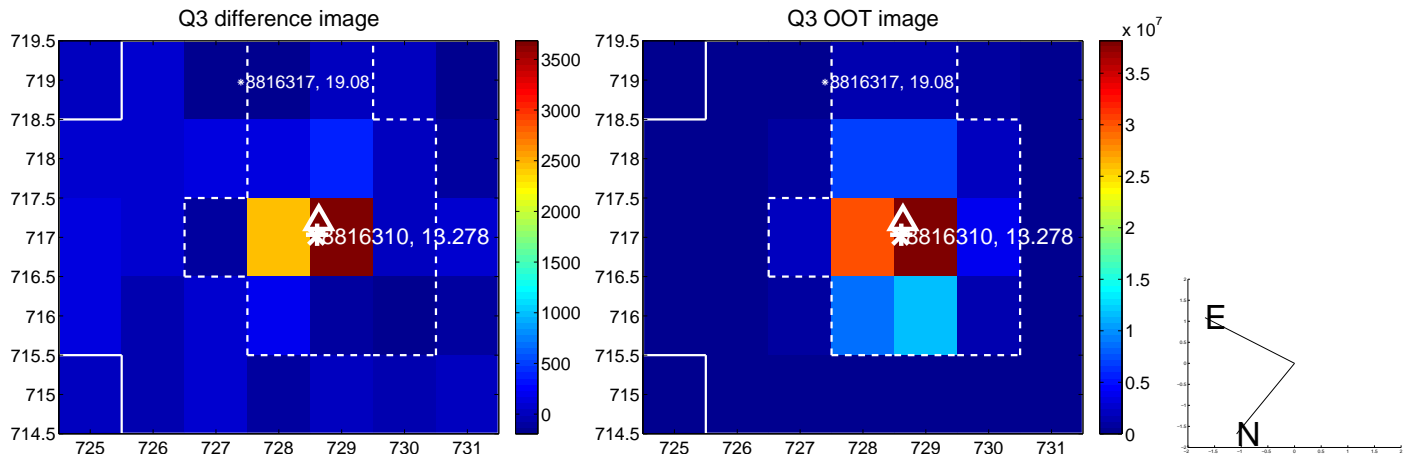
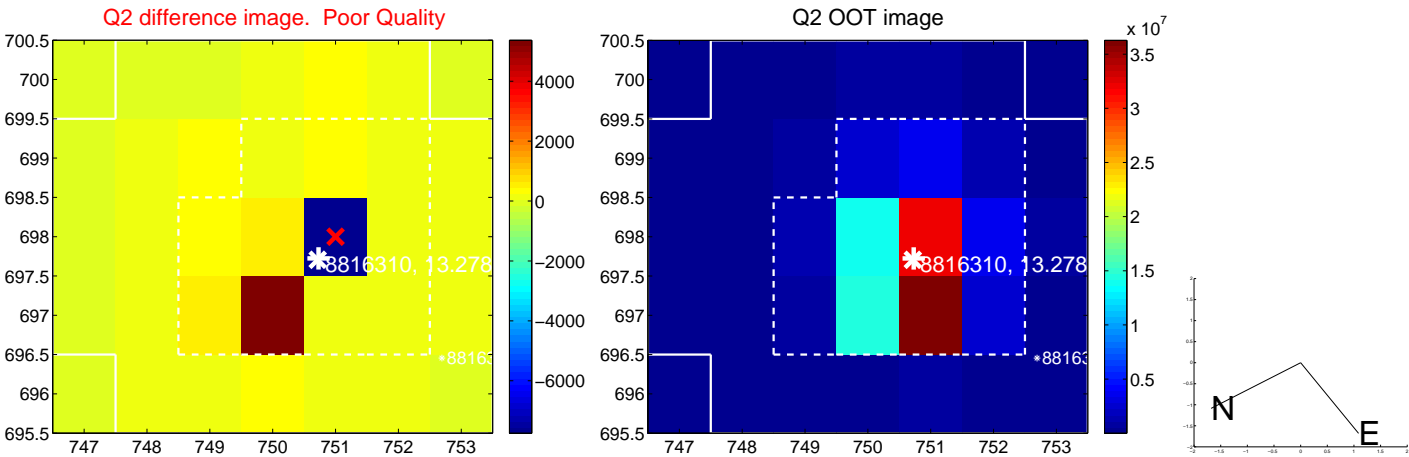
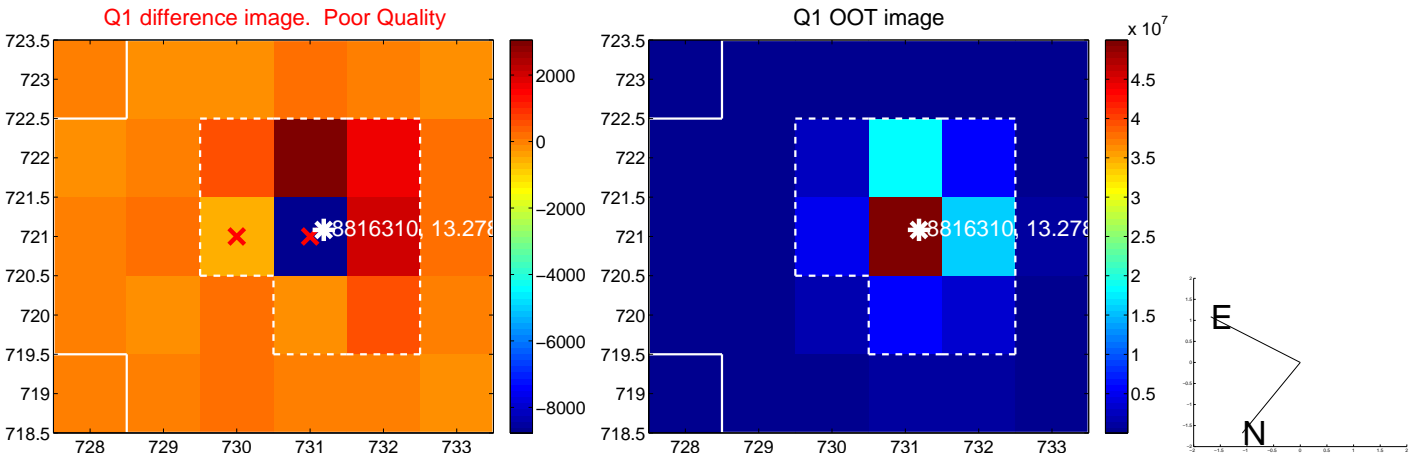
	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.317 \pm 0.508$	0.62	$0.268 \pm 0.381$	$0.171 \pm 0.680$
PRF-fit source offset from KIC position	$0.305 \pm 0.462$	0.66	$0.287 \pm 0.390$	$0.102 \pm 0.660$
photometric centroid source offset	$0.25 \pm 0.58$	0.44	$0.16 \pm 0.58$	$-0.19 \pm 0.57$



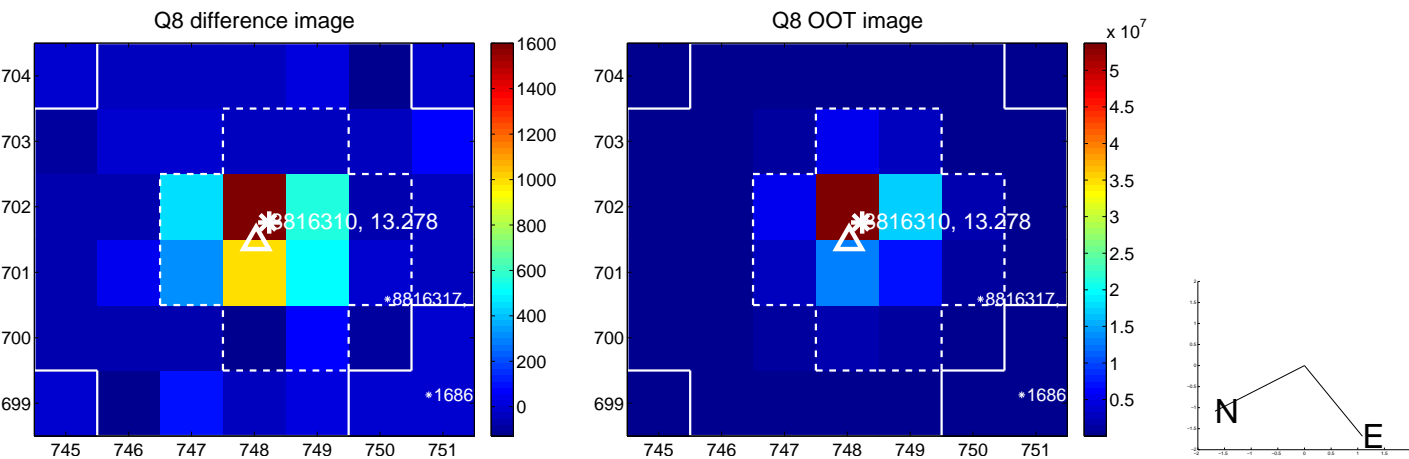
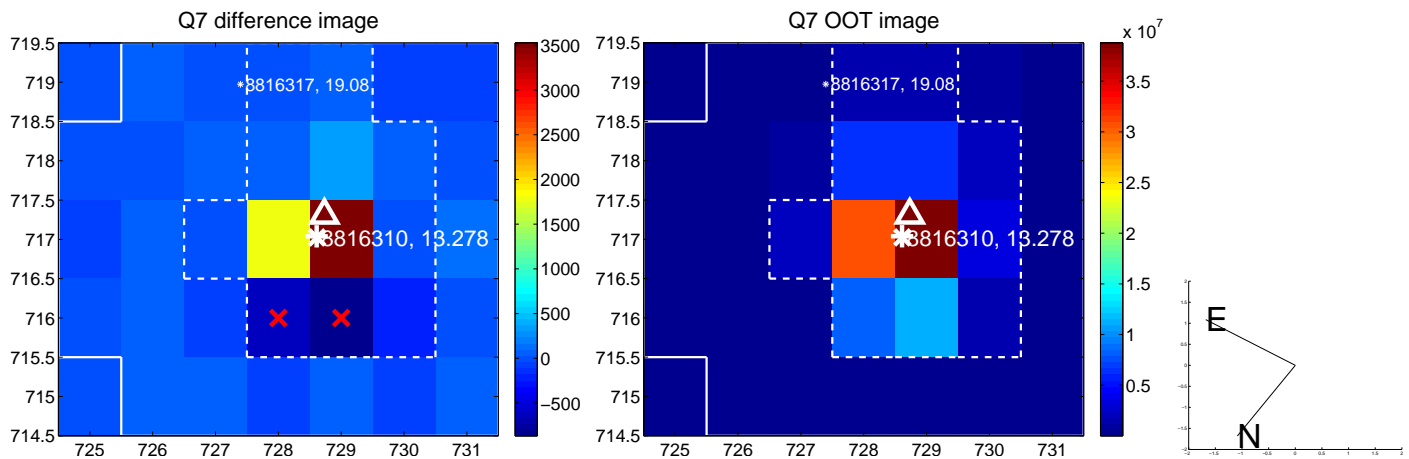
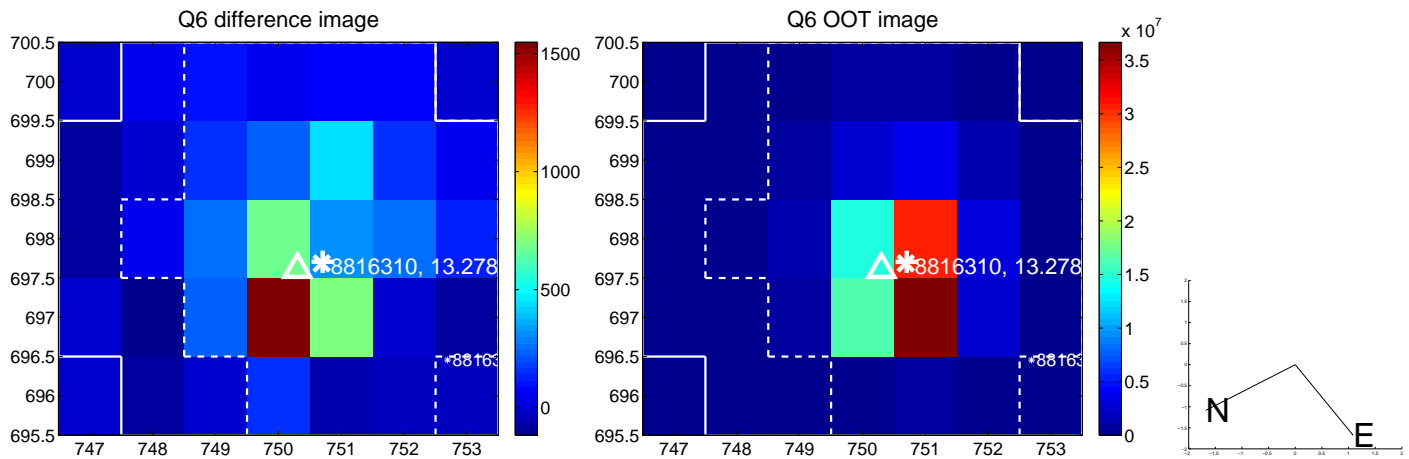
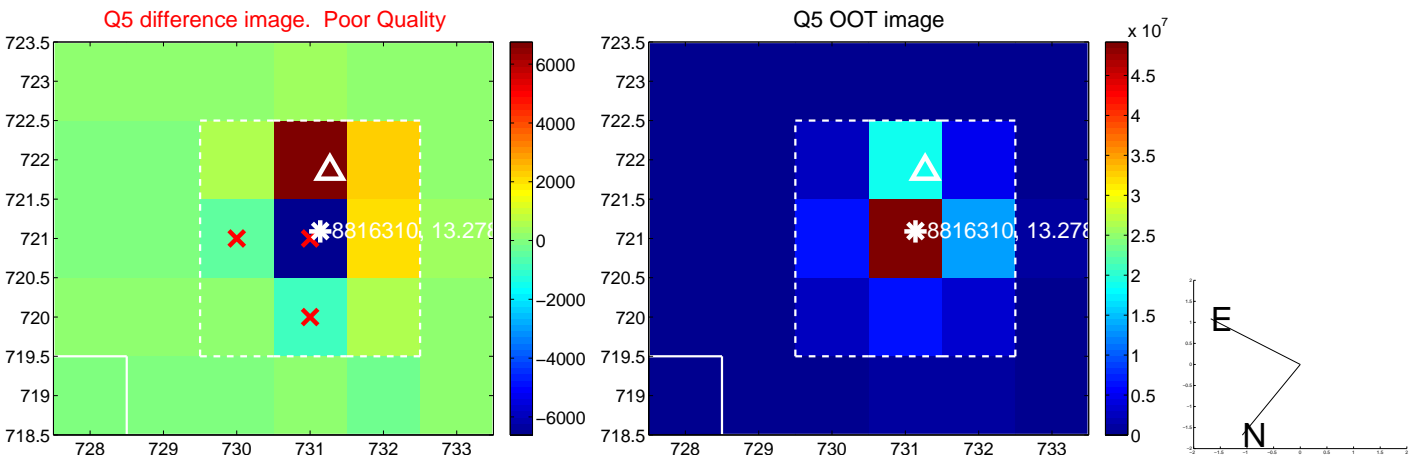
Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets**; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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



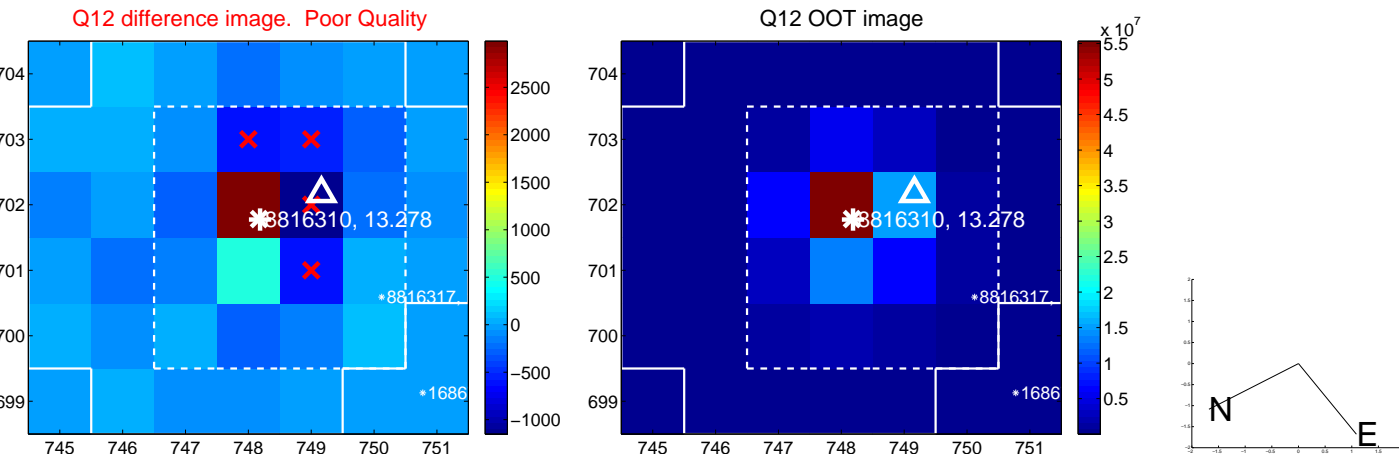
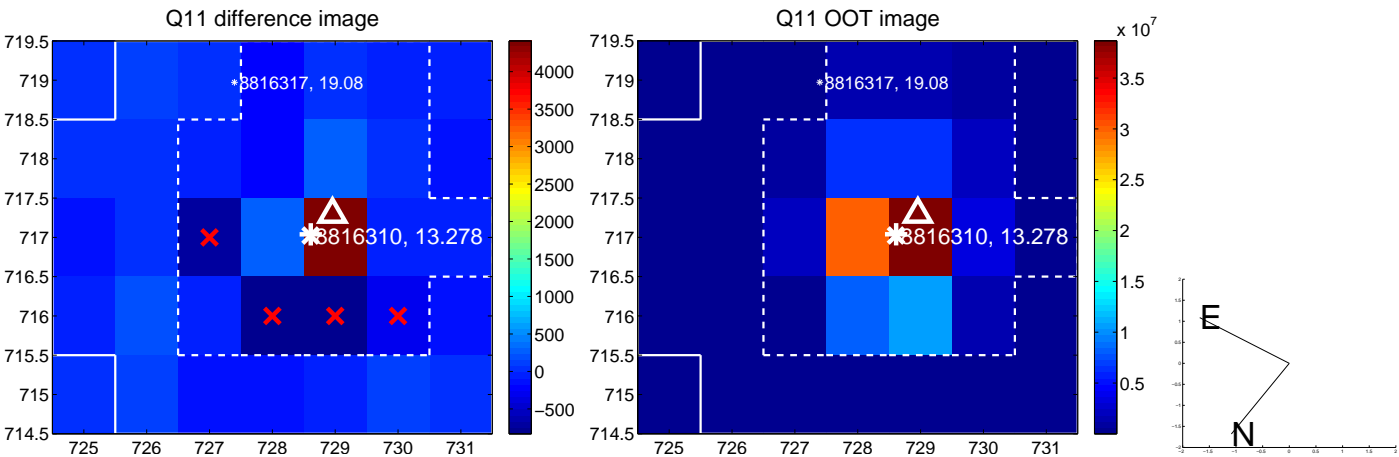
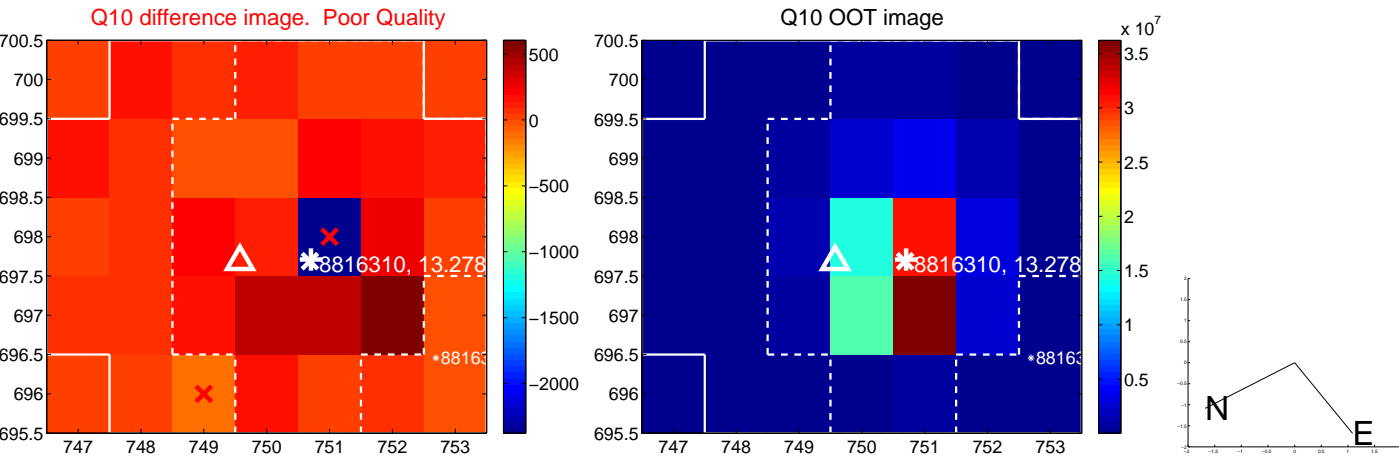
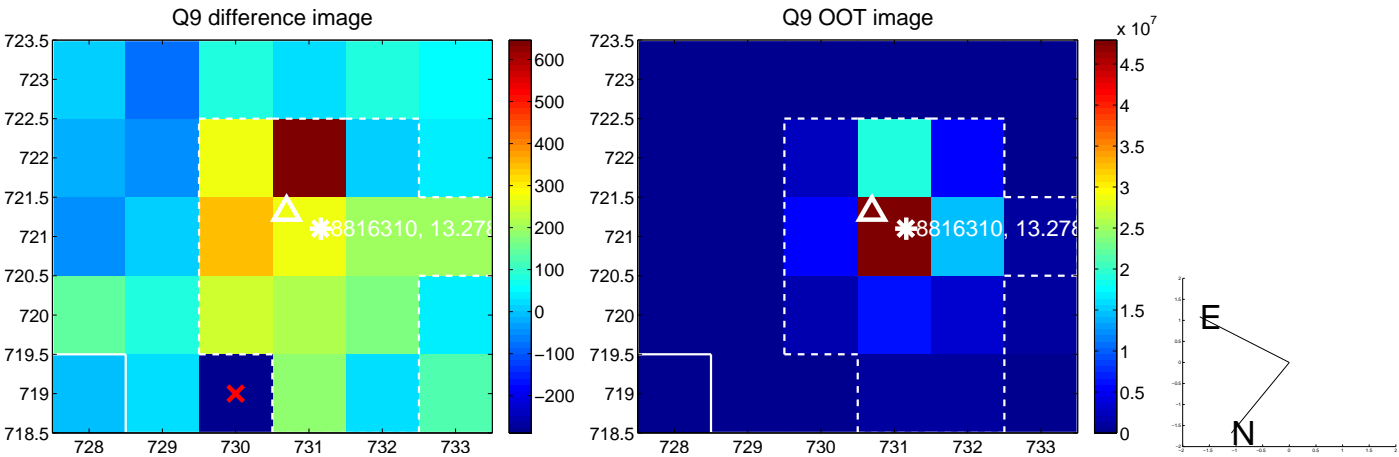
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



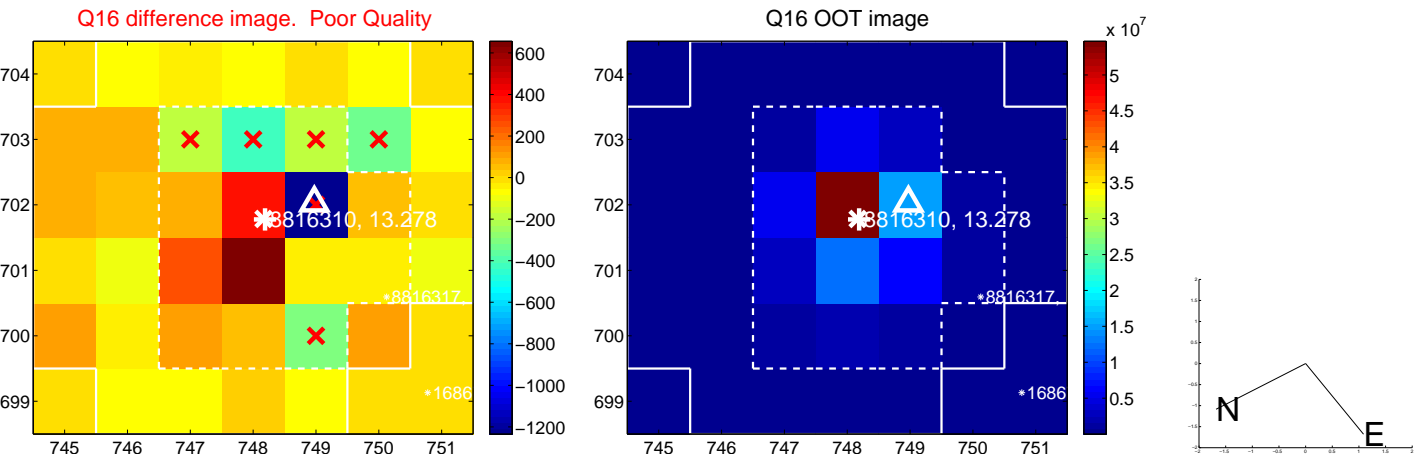
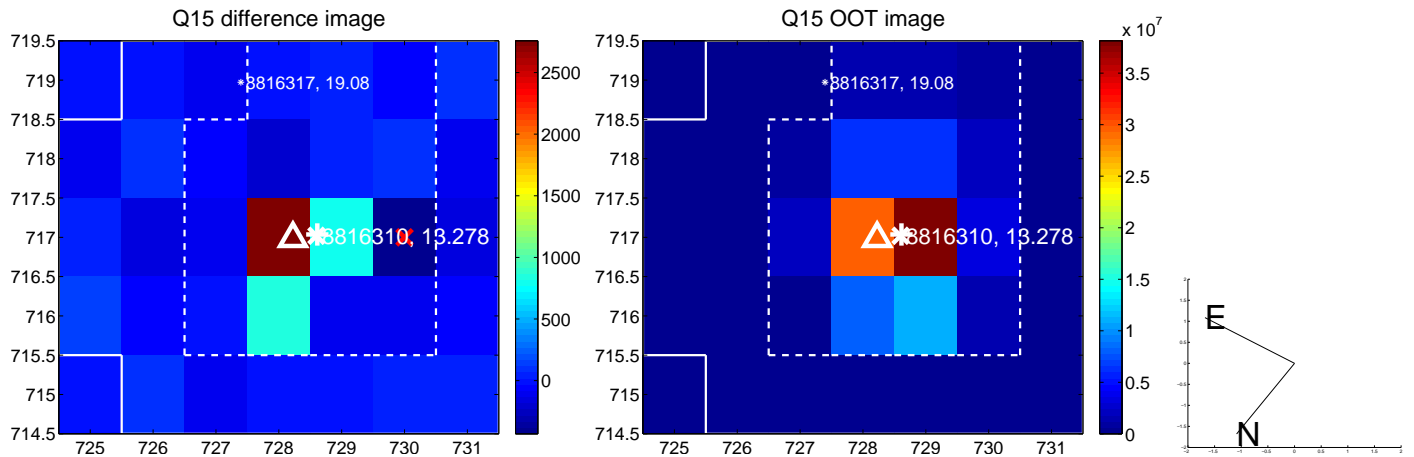
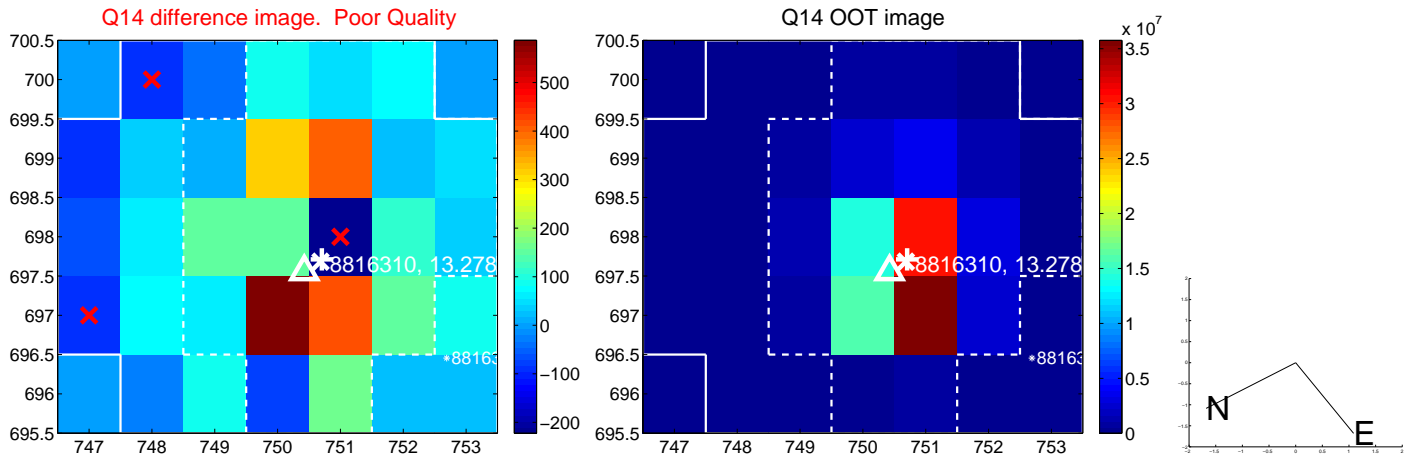
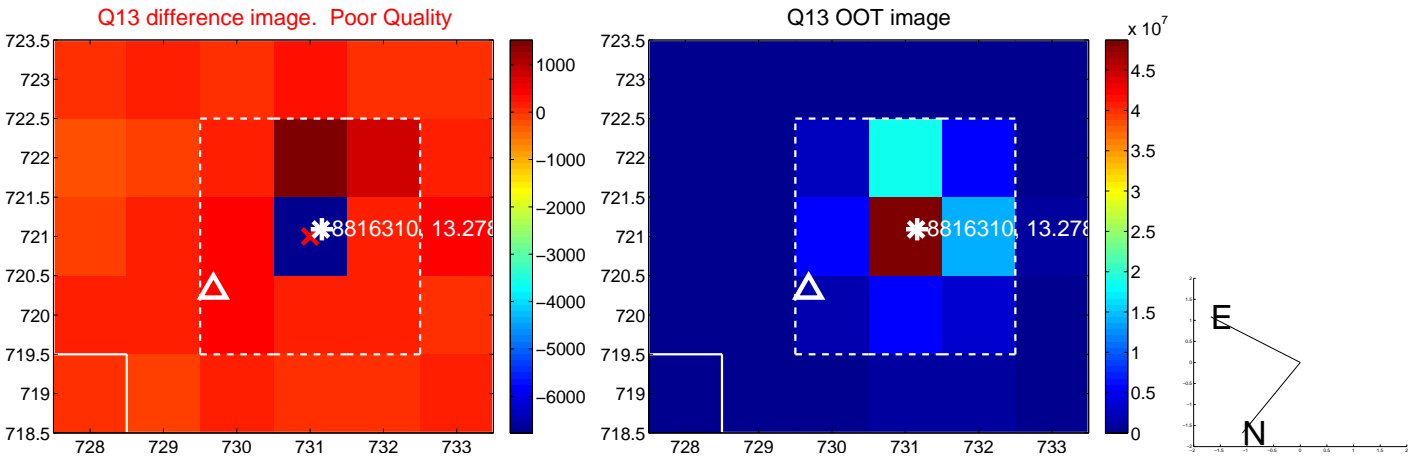
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



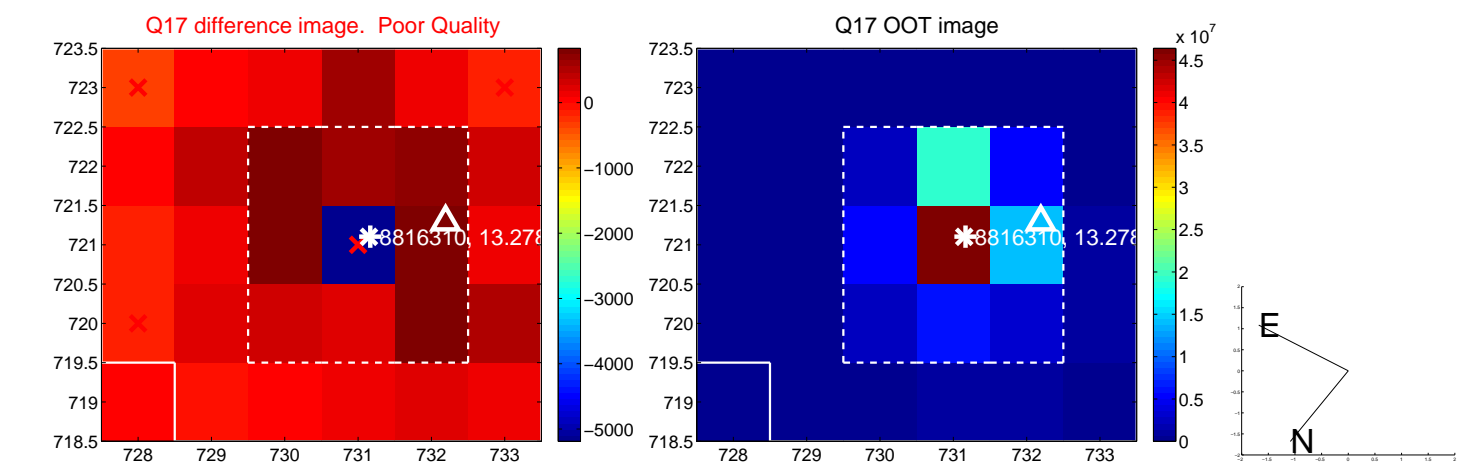
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



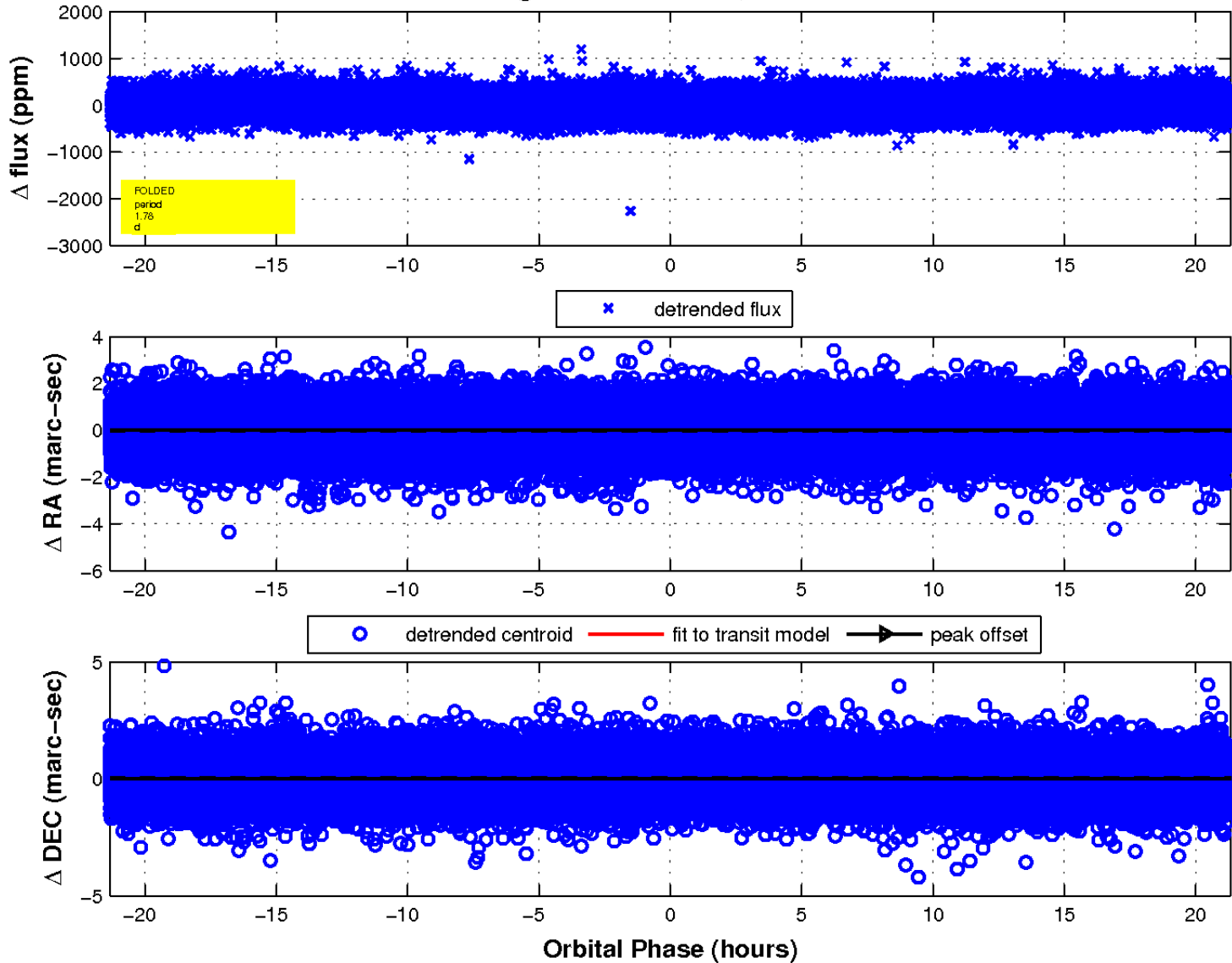
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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



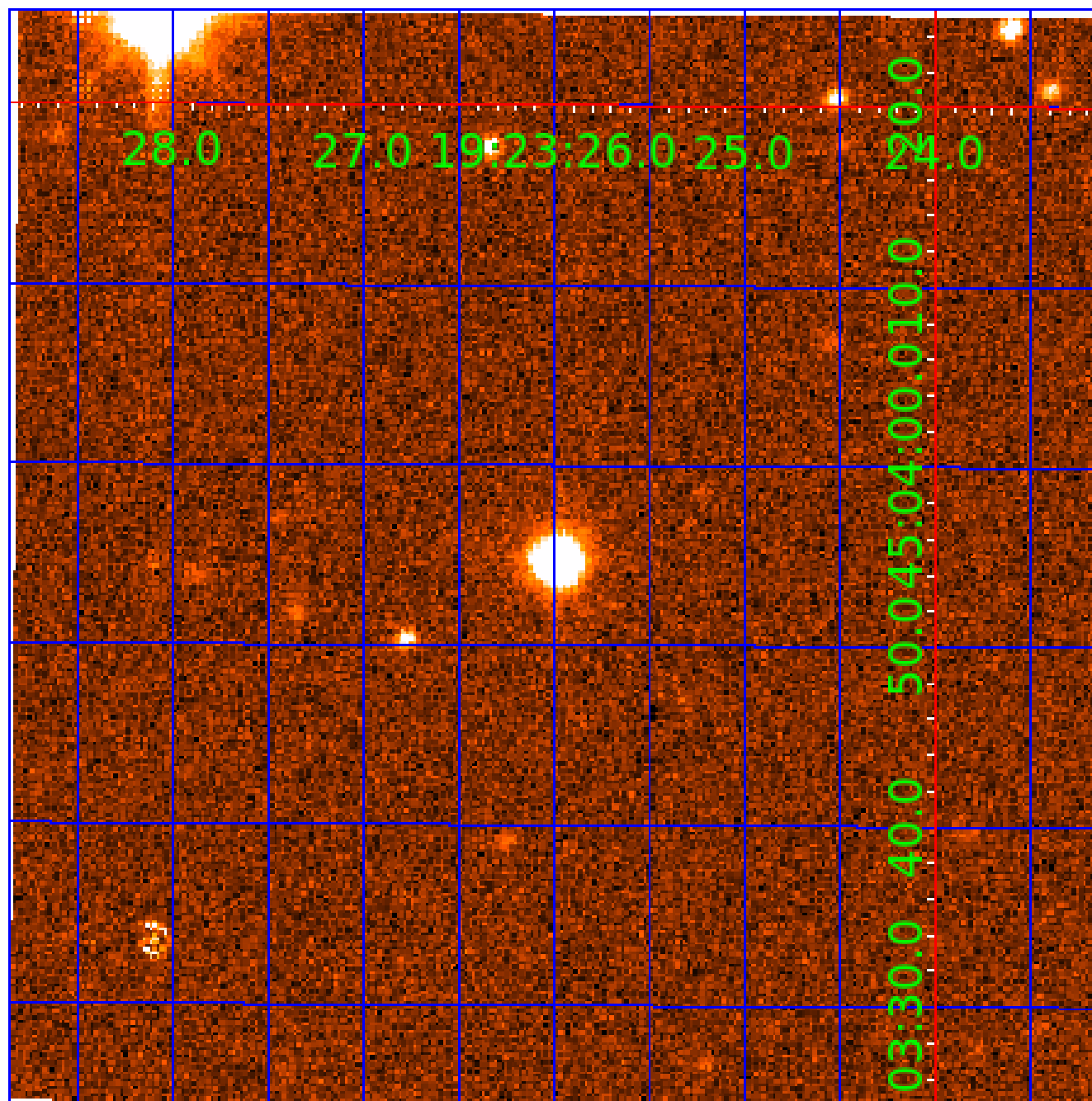
fluxWeightedCentroids, Planet 2 of 4





UKIRT Image

Declination



# KIC 008816310

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
008816310-01	OBS	No	1.778418	133.372527	43.2	5.138	12.5	9.9	1.63	7268	1.82	6466.61
008816310-02	OBS	No	1.778513	132.994912	28.6	13.482	13.7	11.5	1.63	7268	0.89	6466.15
008816310-03	OBS	No	18.408321	149.891981	340.6	1.687	22.4	18.9	1.63	7268	3.32	286.66
008816310-04	OBS	No	20.754171	135.005786	441.9	2.500	12.7	-1.0	1.63	7268	3.49	244.29

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
008816310-01	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_SKYE_ZUMA_TRACKER—LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—MOD_NONUNIQ_ALT
008816310-02	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_SKYE_ZUMA_TRACKER—LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—SAME_NTL_PERIOD
008816310-03	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_SKYE—TRANS_GAPPED—LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—MOD_NONUNIQ_ALT
008816310-04	OBS	FP	0.00	1	0	1	0	INDIV_TRANS_RUBBLE—TRANS_GAPPED—LPP_DV—LPP_ALT—MOD_NONUNIQ_ALT—MOD_TER_ALT—MOD_POS_ALT—CENT_NOFITS—HALO_GHOST

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

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

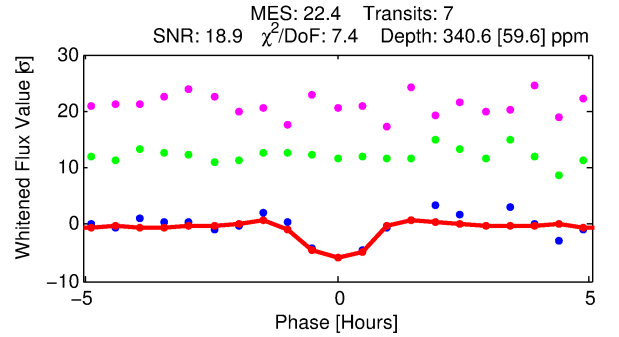
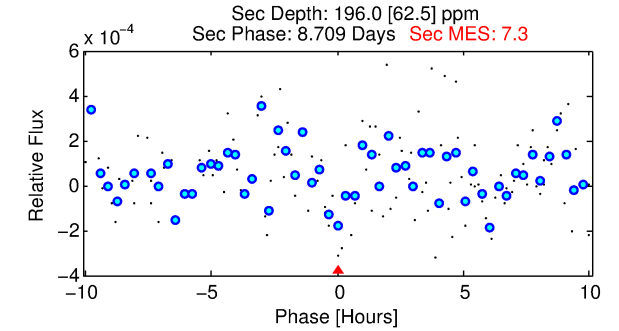
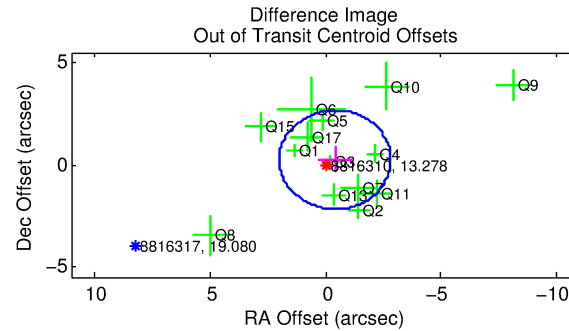
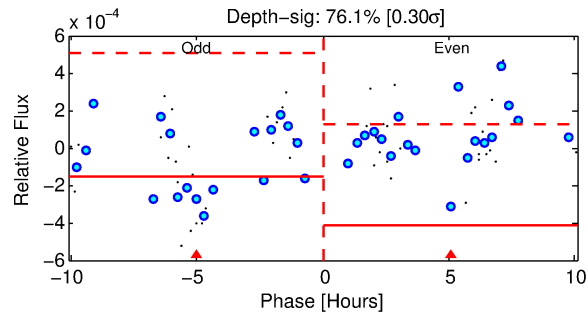
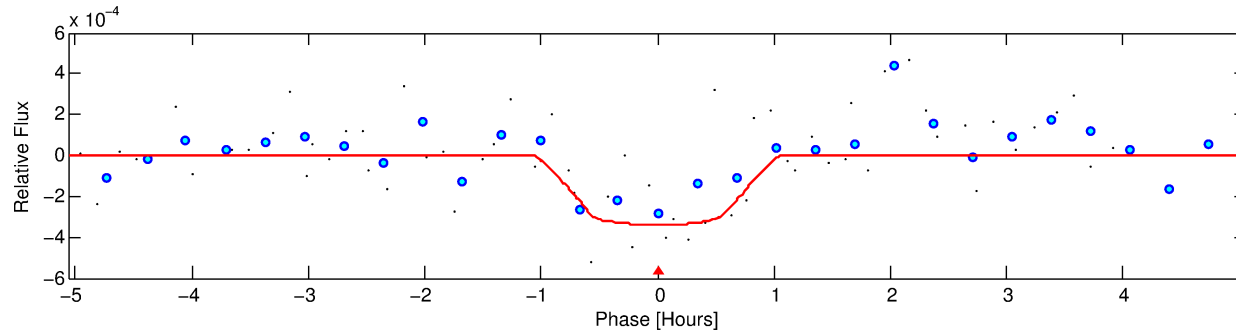
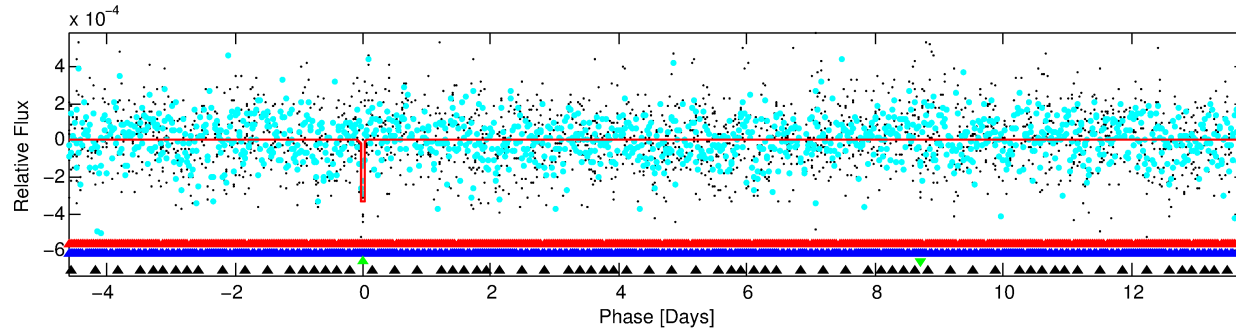
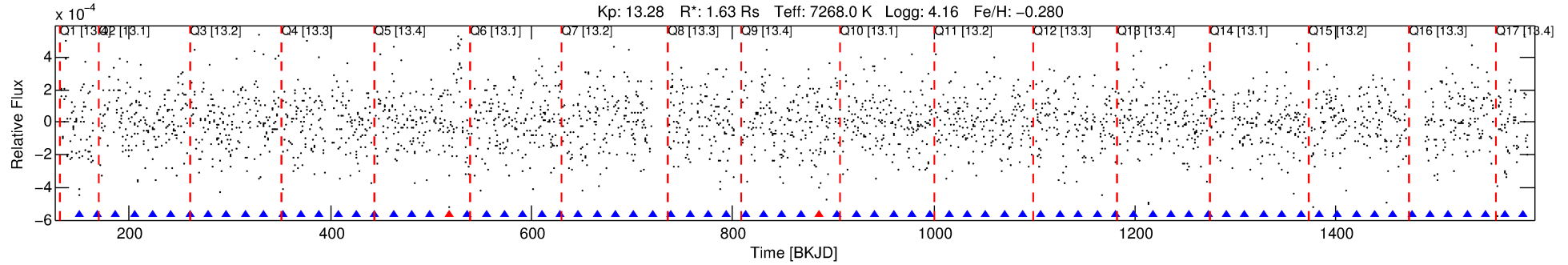
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

Ephemeris Match Information For 008816310-03

No Significant Match Found

# DV One-Page Summary

KIC: 8816310 Candidate: 3 of 4 Period: 18.408 d



## DV Fit Results:

Period = 18.40832 [0.00015] d  
Epoch = 149.8920 [0.0049] BKJD  
Rp/R\* = 0.0186 [0.0291]  
a/R\* = 53.87 [523.06]  
b = 0.79 [4.72]  
Seff = 286.66 [111.16]  
Teq = 1049 [102] K  
Rp = 3.32 [5.29] Re  
a = 0.1526 [0.0387] AU  
Ag = 228.34 [722.53] [0.31 $\sigma$ ]  
Teffp = 6306 [4965] K [1.06 $\sigma$ ]

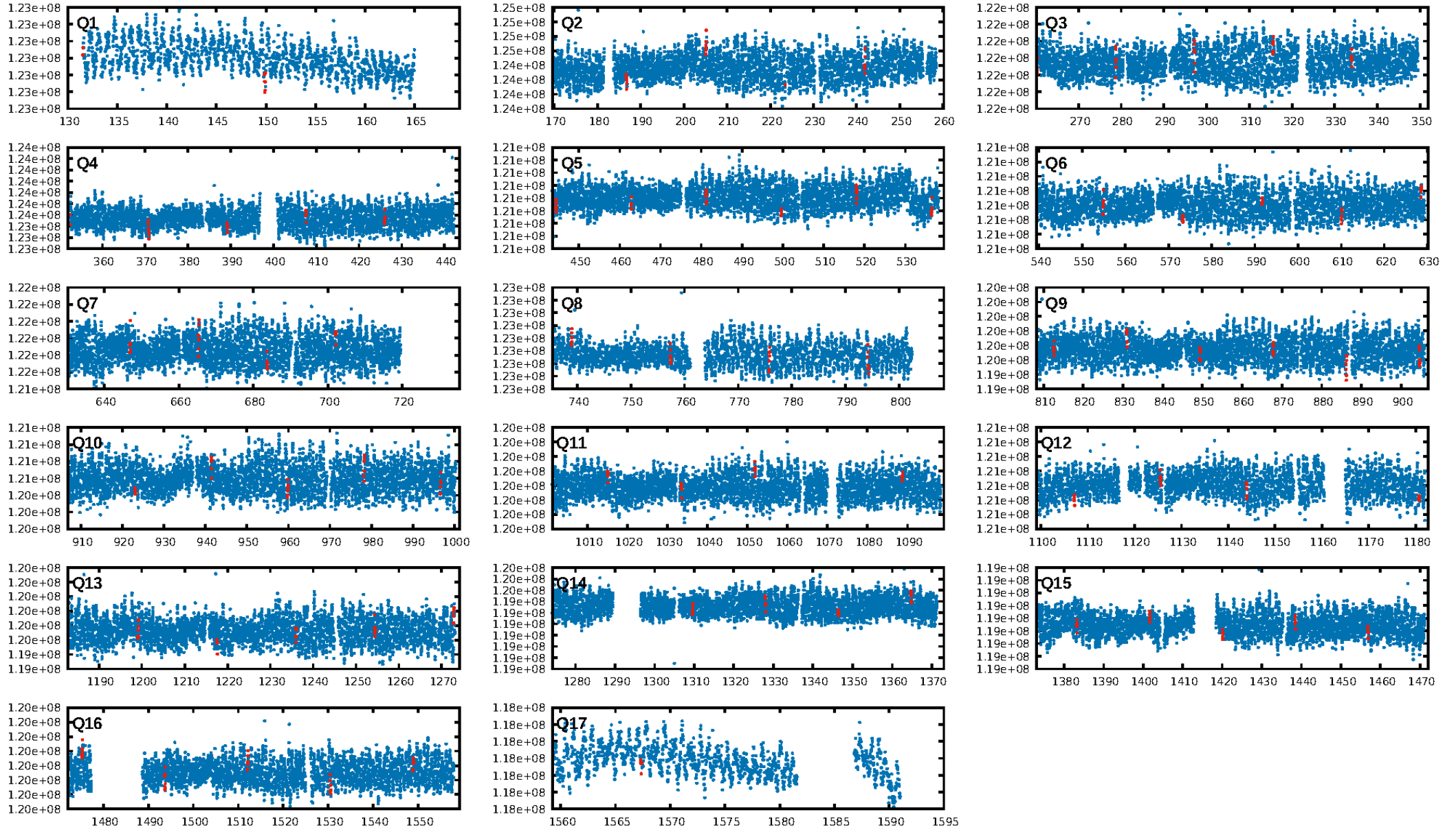
## DV Diagnostic Results:

ShortPeriod-sig: 100.0% [29.38 $\sigma$ ]  
LongPeriod-sig: 100.0% [18.67 $\sigma$ ]  
ModelChiSquare2-sig: 0.0%  
ModelChiSquareGof-sig: 0.0%  
Bootstrap-pfa: 1.48e-42  
RollingBand-fgt: 0.60 [3/5]  
GhostDiagnostic-chr: -3.269  
Centroid-sig: 32.9%  
Centroid-so: 0.389 arcsec [0.91 $\sigma$ ]  
OotOffset-rm: 0.473 arcsec [0.59 $\sigma$ ]  
OotOffset-st: 3/4/2/5 [14]  
KicOffset-rm: 0.457 arcsec [0.57 $\sigma$ ]  
KicOffset-st: 3/4/2/5 [14]  
DiffImageQuality-fgm: 0.43 [6/14]  
DiffImageOverlap-fno: 1.00 [17/17]

Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 31-Jan-2016 19:06:11 Z

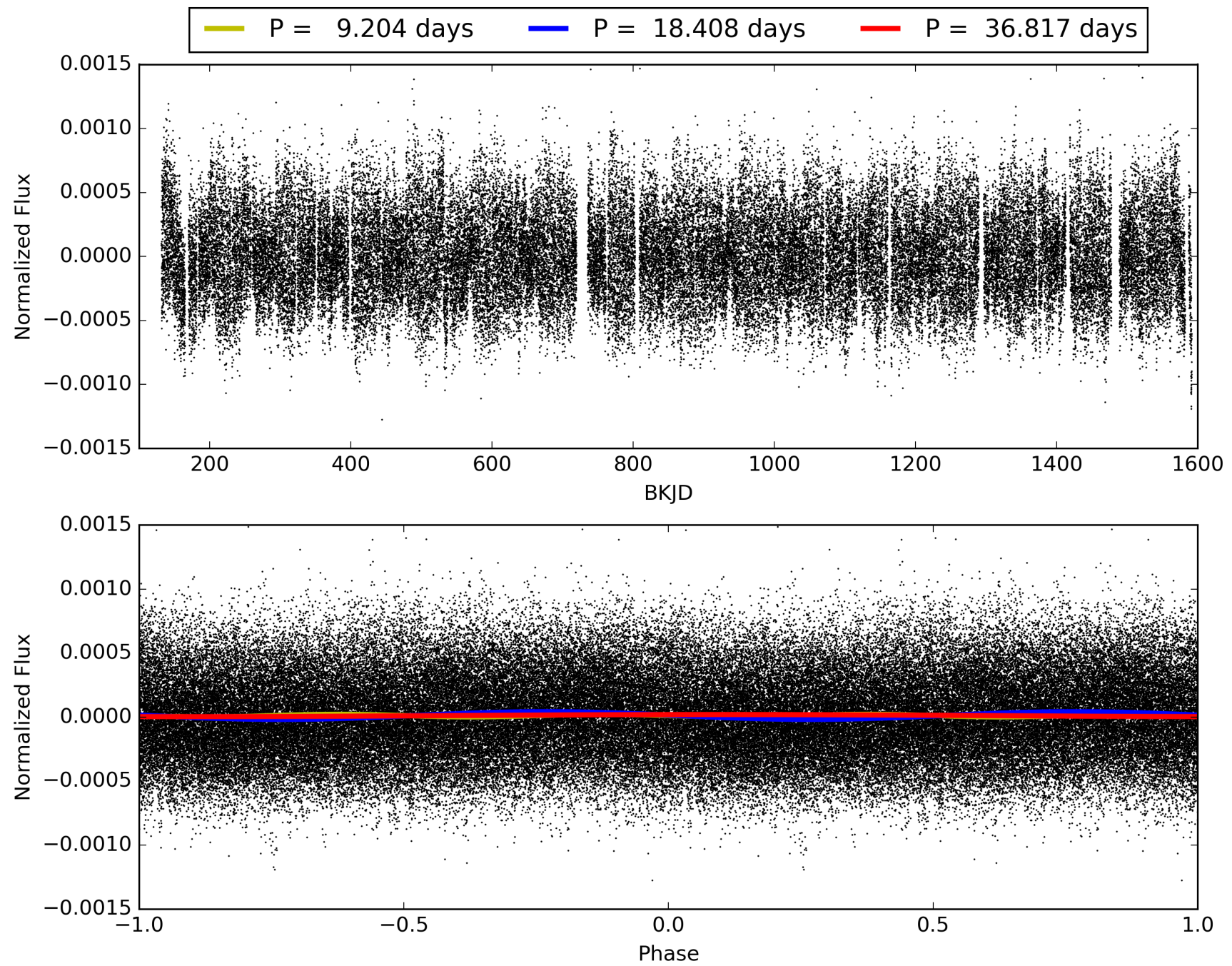
This Data Validation Report Summary was produced in the Kepler Science Operations Center Pipeline at NASA Ames Research Center

# TCE 008816310-03, PDC Light Curves



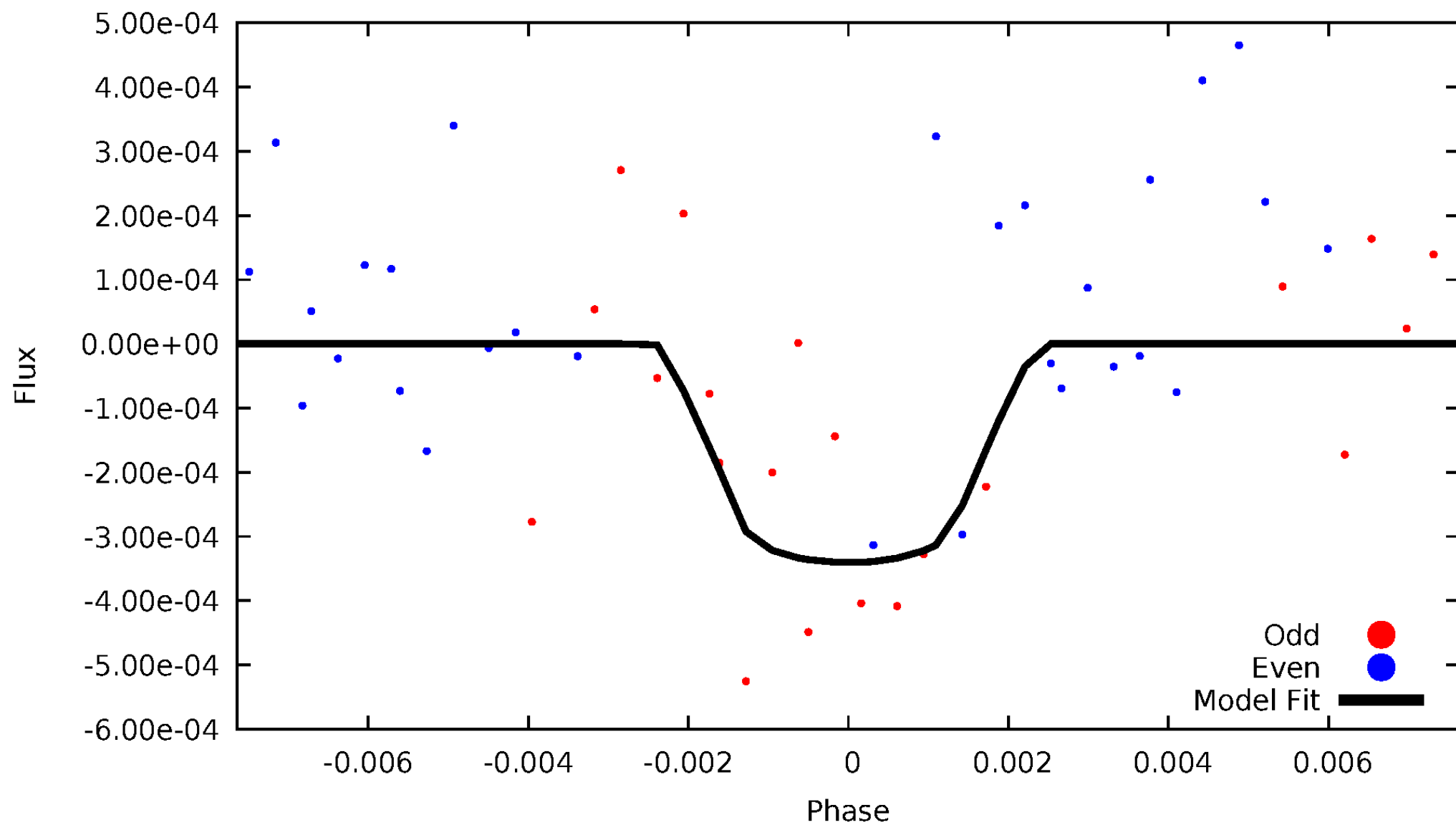


TCE 008816310-03



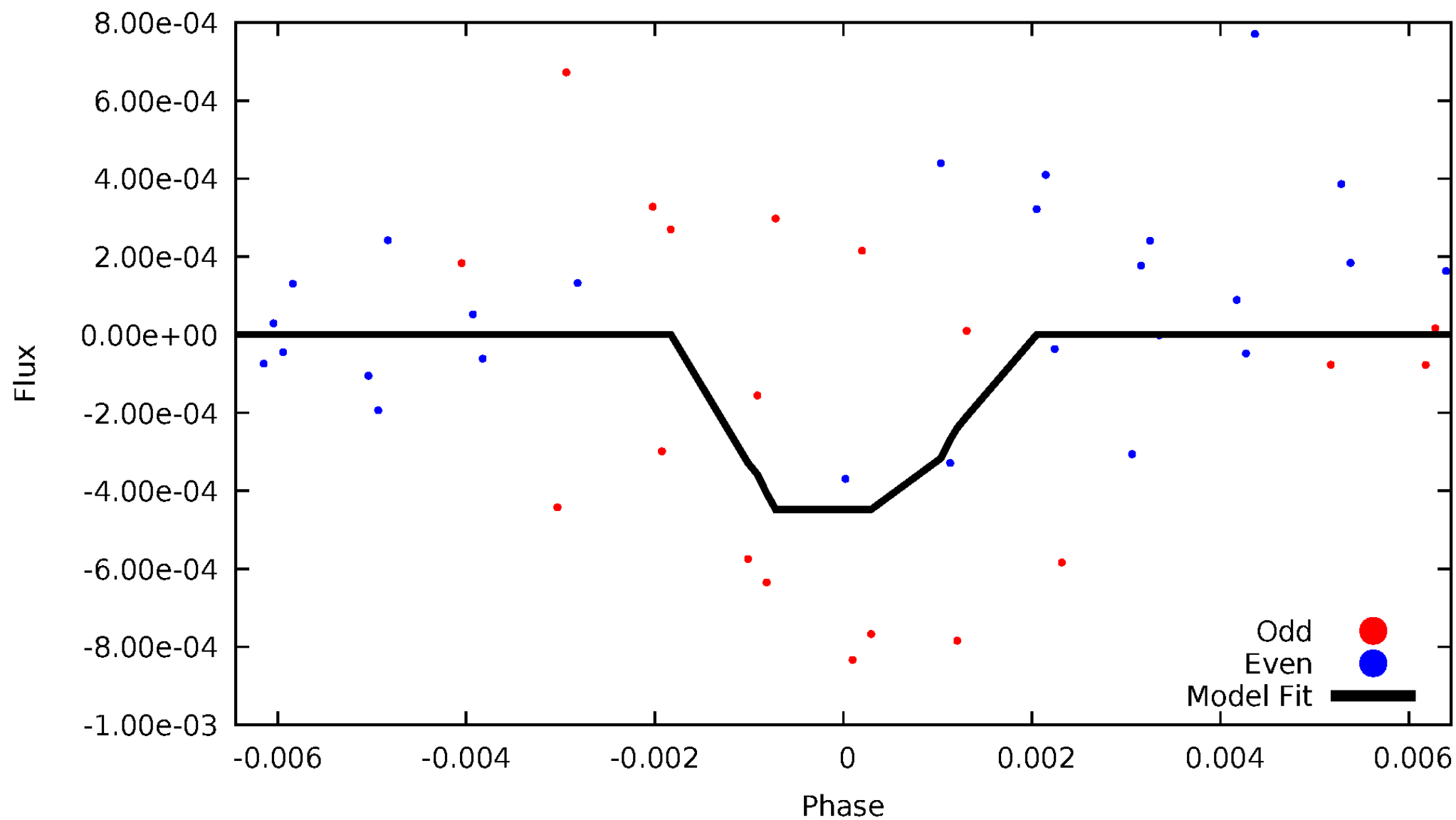
# DV Odd/Even

TCE 008816310-03



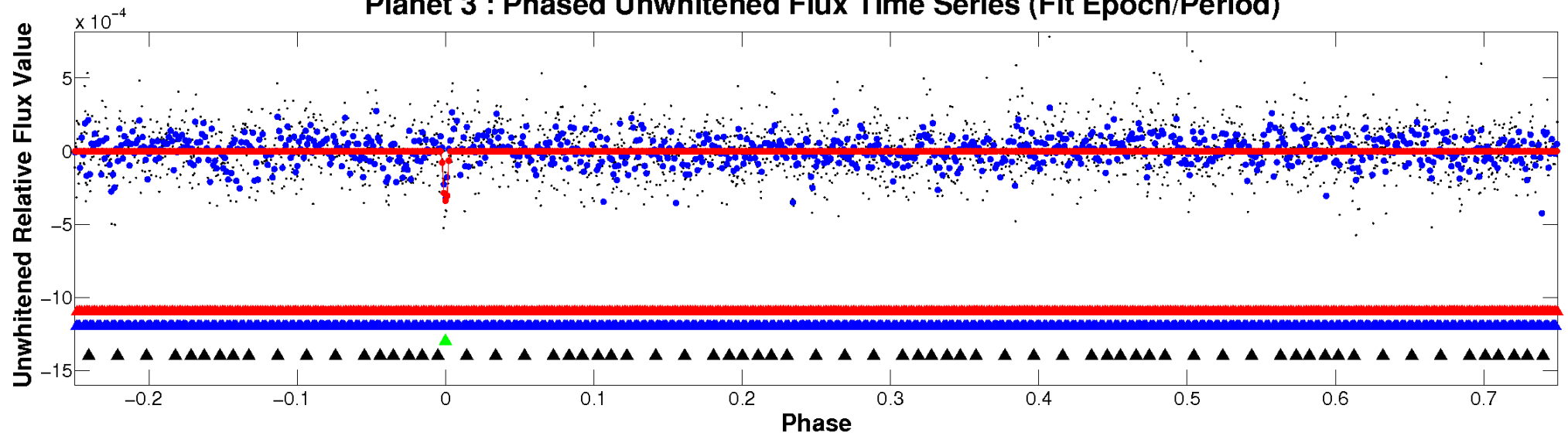
# ALT Odd/Even

TCE 008816310-03

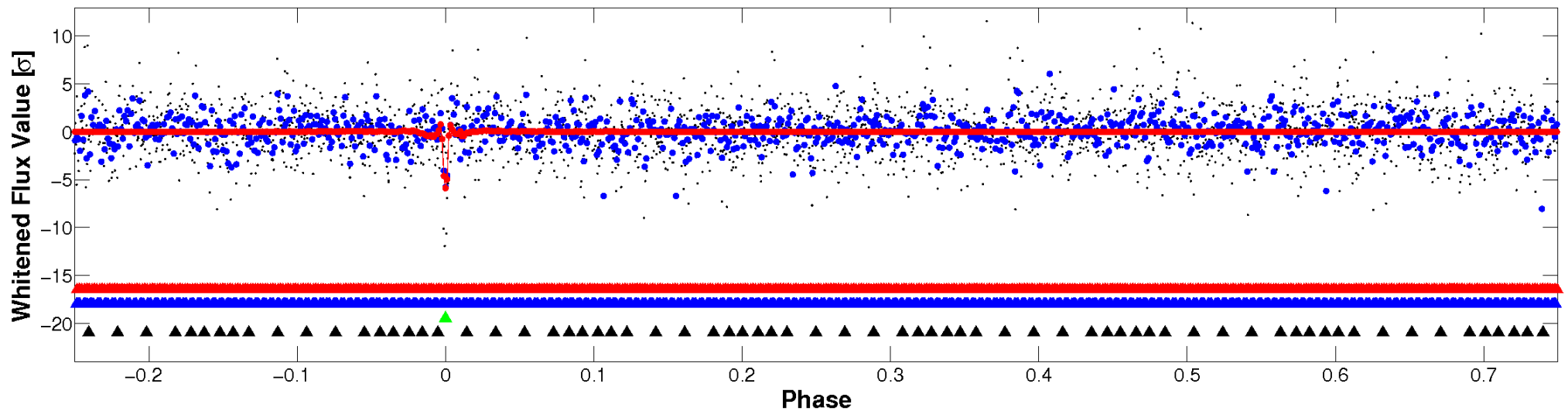


# Non-Whitened Vs. Whitened Light Curve

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



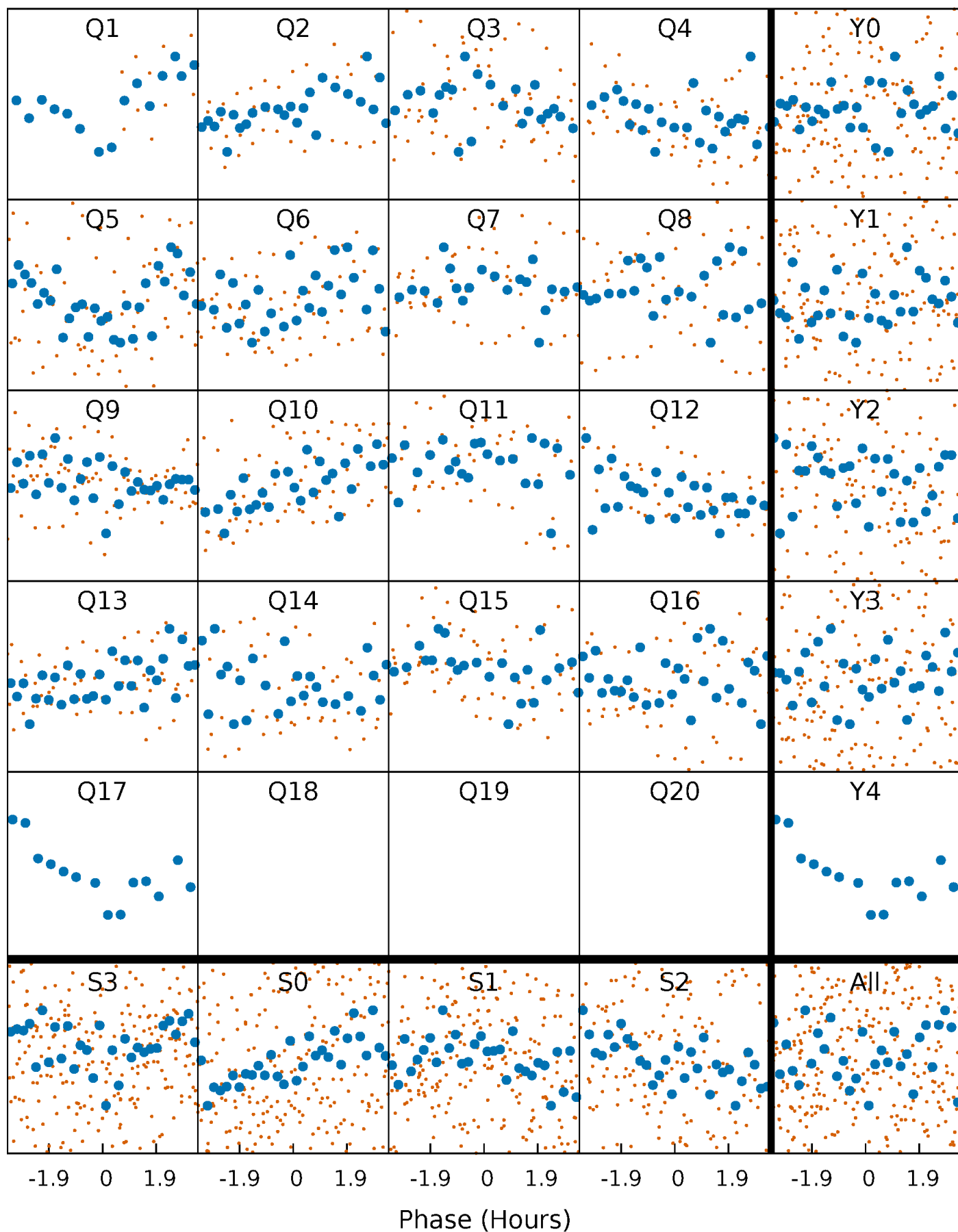
## Planet 3 : Phased Whitened Flux Time Series (Fit Epoch/Period)





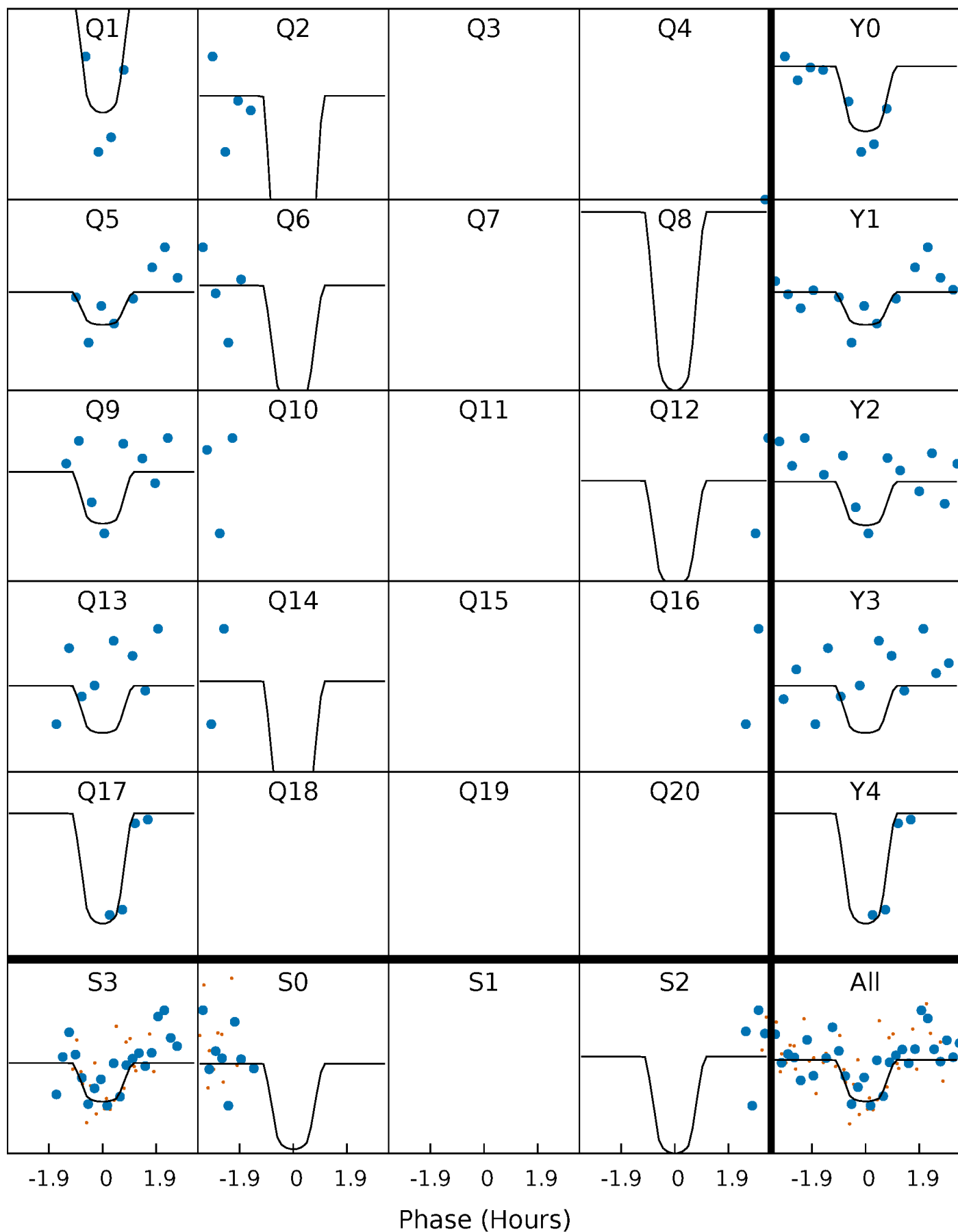
# PDC Quarter-Phased Transit Curves

TCE 008816310-03 P= 18.408321 Days  $T_0=149.891981$  (BKJD)



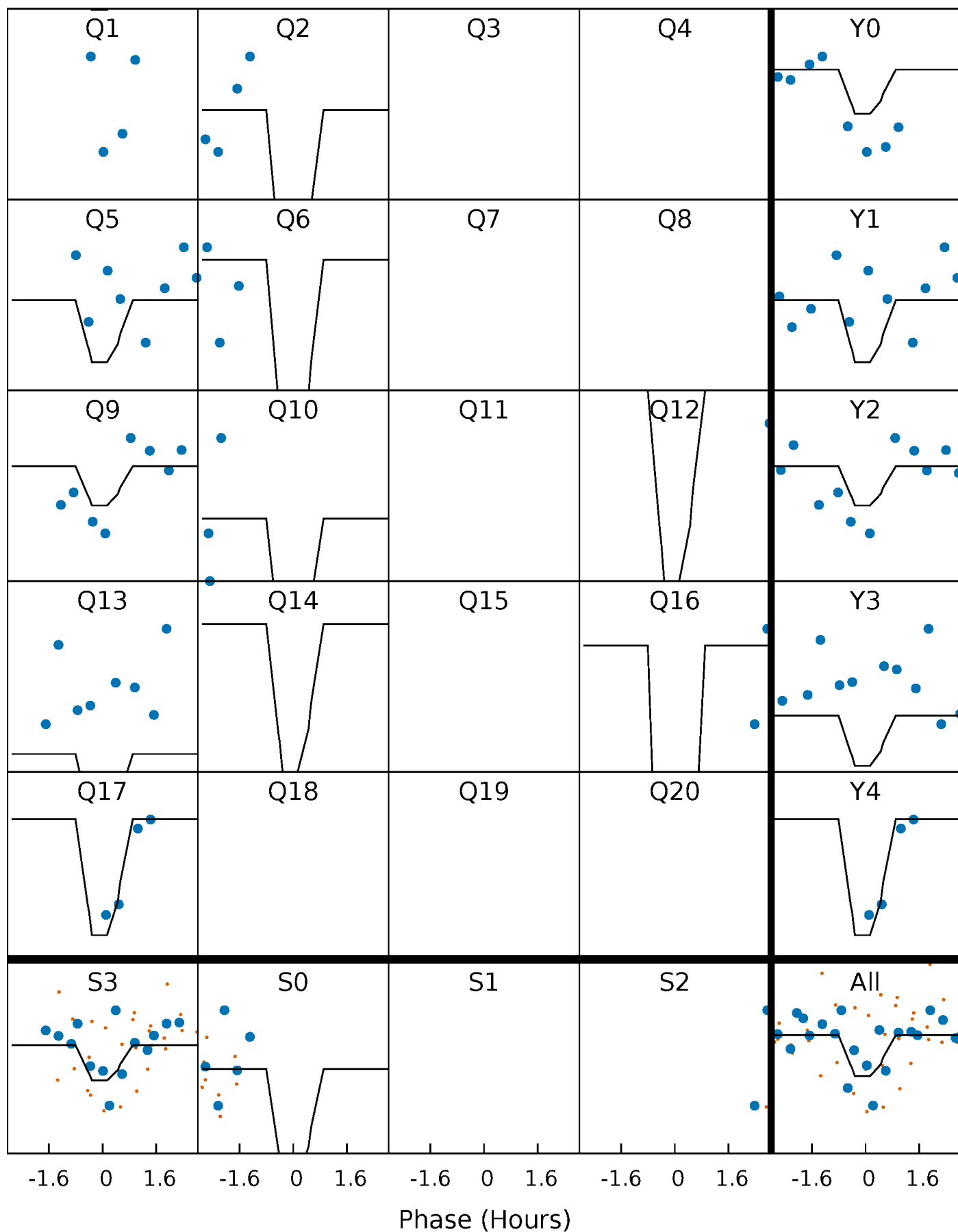
# DV Quarter-Phased Transit Curves

TCE 008816310-03   P= 18.408321 Days    $T_0=149.891981$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

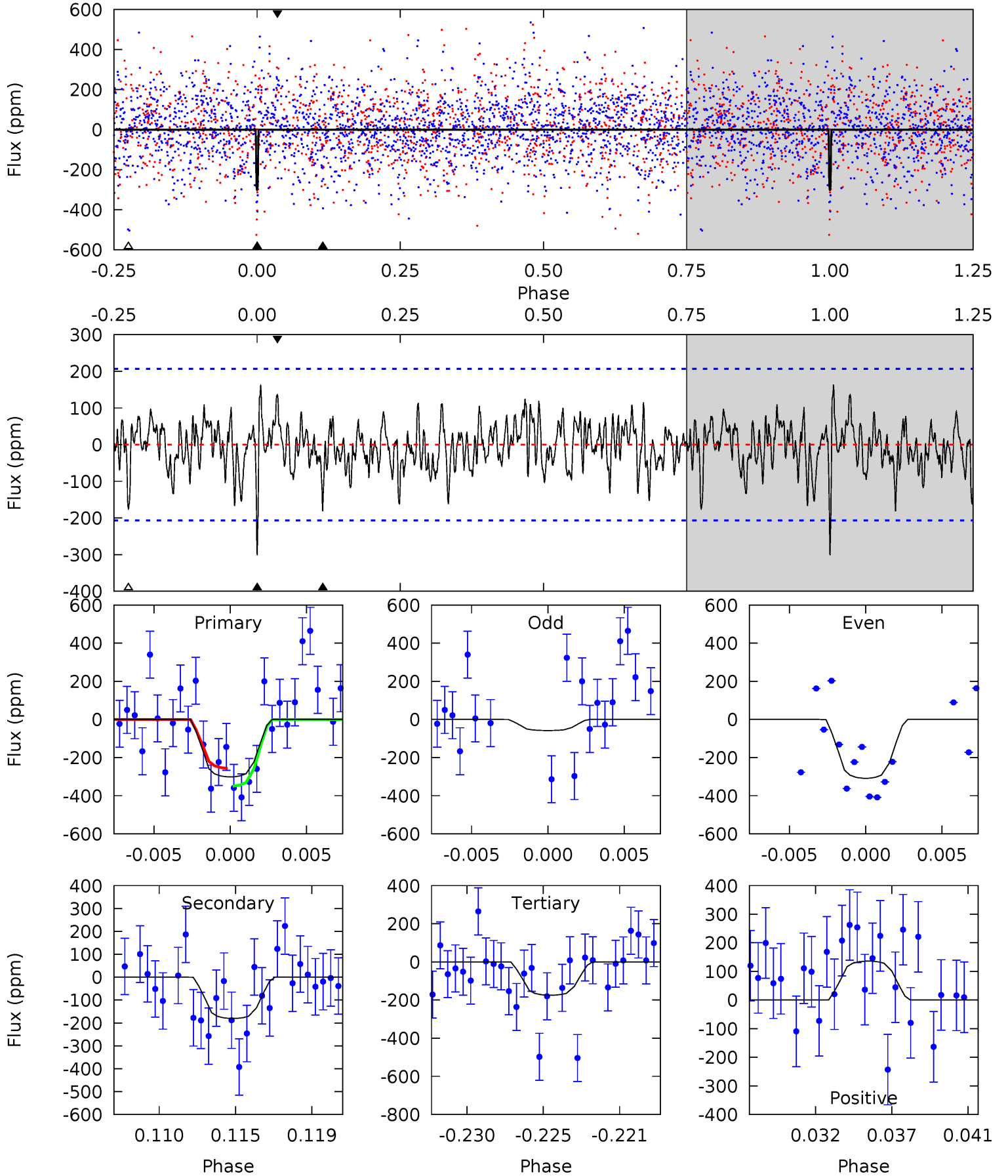
TCE 008816310-03 P= 18.408533 Days  $T_0=149.880977$  (BKJD)



# DV Model-Shift Uniqueness Test

008816310-03, P = 18.408321 Days, E = 131.483660 Days

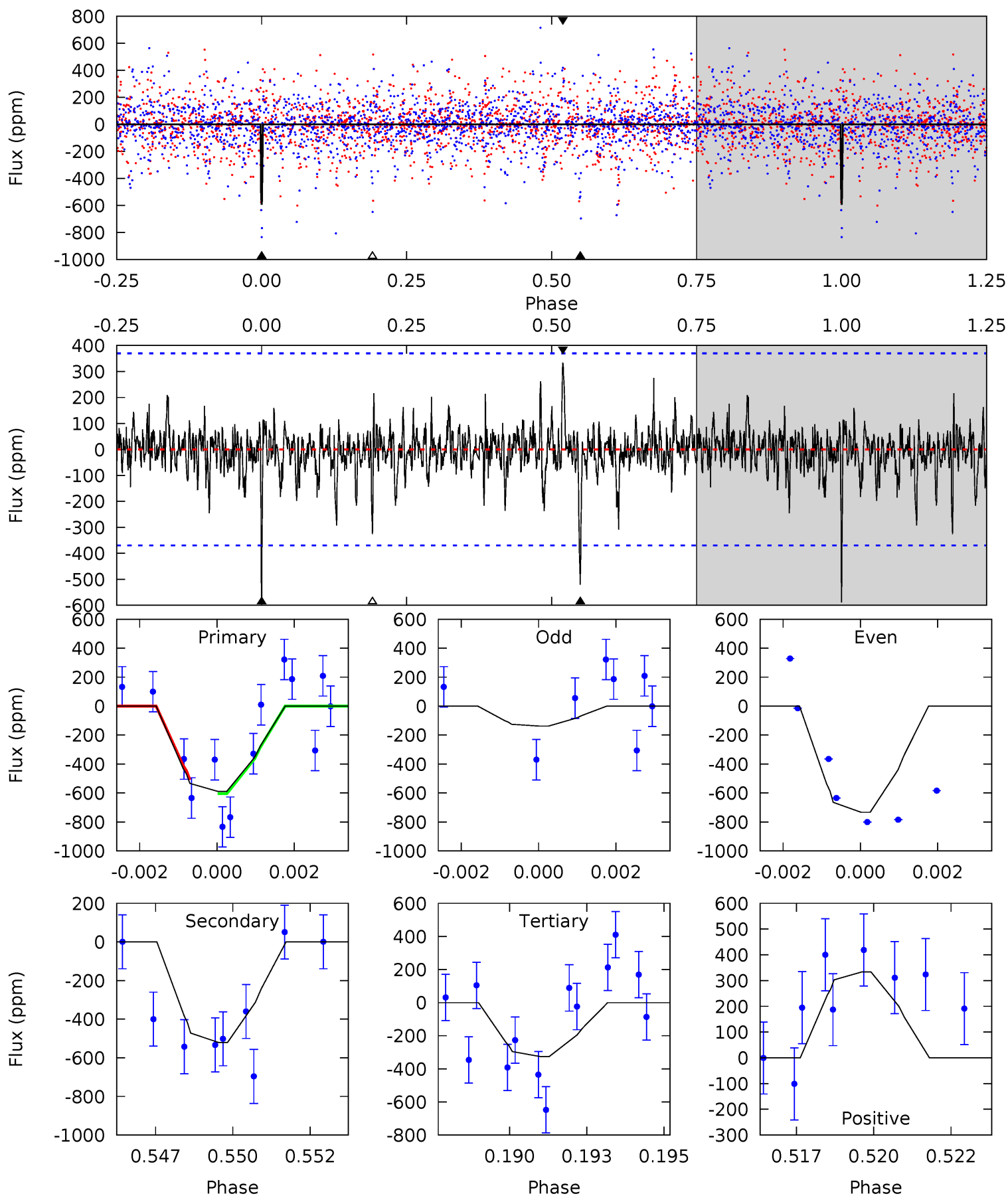
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
7.54	4.52	4.37	3.40	5.17	2.83	1.38	3.17	4.14	0.15	1.11	2.79	0.56	0.35	1.17



# Alt Model-Shift Uniqueness Test

008816310-03,  $P = 18.408533$  Days,  $E = 131.472444$  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
8.44	7.46	4.67	4.78	5.30	3.05	1.01	3.77	3.66	2.79	2.67	4.93	0.88	0.36	0





### Stellar Parameters For KIC 008816310

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R (R_{\odot})$	$M(M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$7268^{+228}_{-304}$	$4.157^{+0.148}_{-0.181}$	$-0.280^{+0.250}_{-0.350}$	$1.634^{+0.521}_{-0.347}$	$1.399^{+0.204}_{-0.226}$	$0.451^{+0.387}_{-0.220}$
	+3%/-4%	+4%/-4%	+89%/-125%	+32%/-21%	+15%/-16%	+86%/-49%
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 008816310-03 / KOI

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{max} (K)$	$T_{obs} (K)$	$A_{obs}$
DV	$-180 \pm 40$	$5.09^{+4.53}_{-3.41}$	$1460^{+115}_{-92}$	$5000^{+3847}_{-1091}$	$88^{+703}_{-64}$
Alt.	$-520 \pm 70$	$5.07^{+4.98}_{-3.29}$	$1462^{+118}_{-85}$	$6504^{+6691}_{-1715}$	$249^{+1867}_{-182}$

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

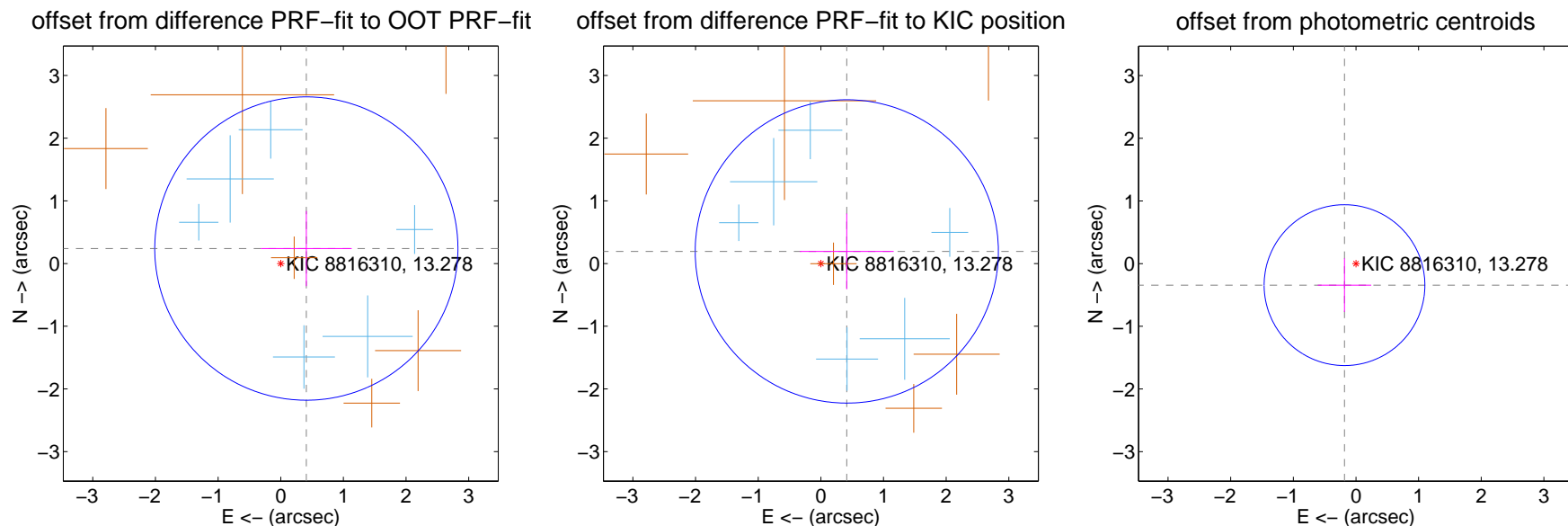
## DV Centroid Data

Supplemental centroid analysis for 008816310-03. Kepler magnitude: 13.28. Transit SNR 18.90

There are 6 quarters with good PRF difference image offsets

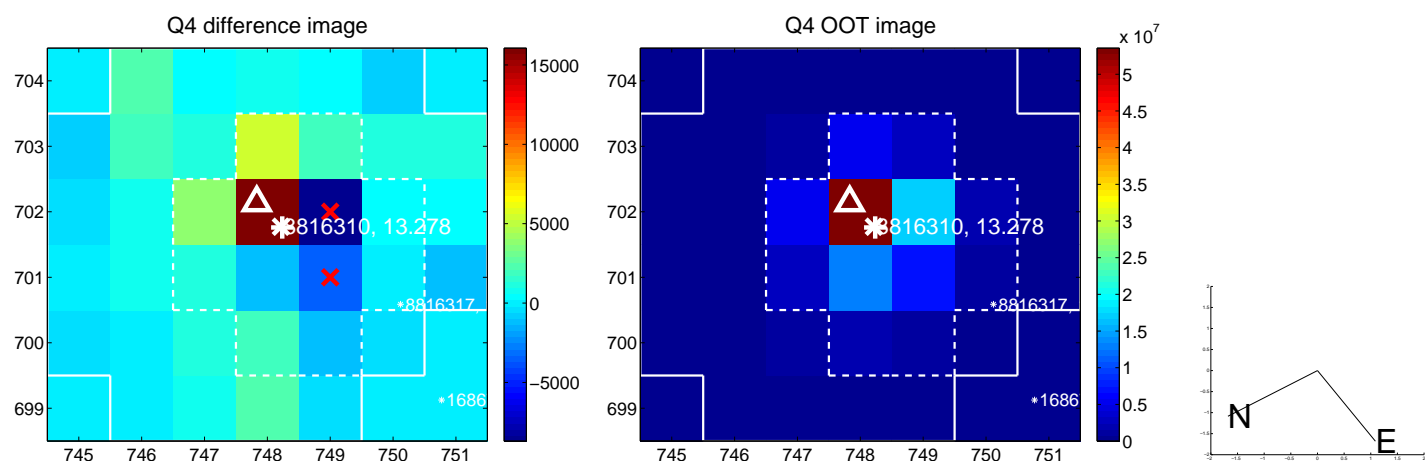
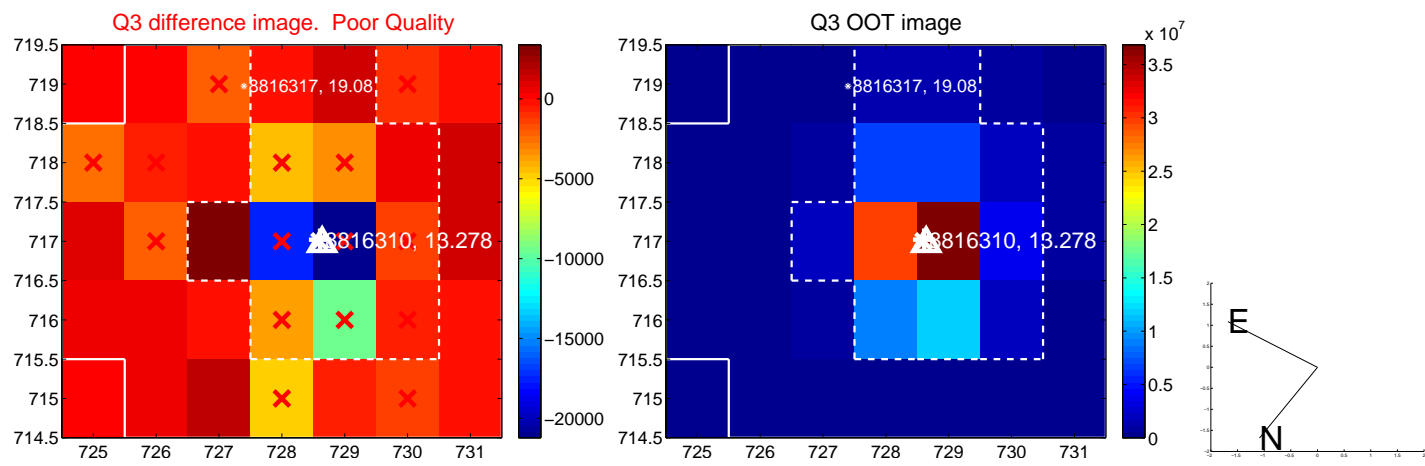
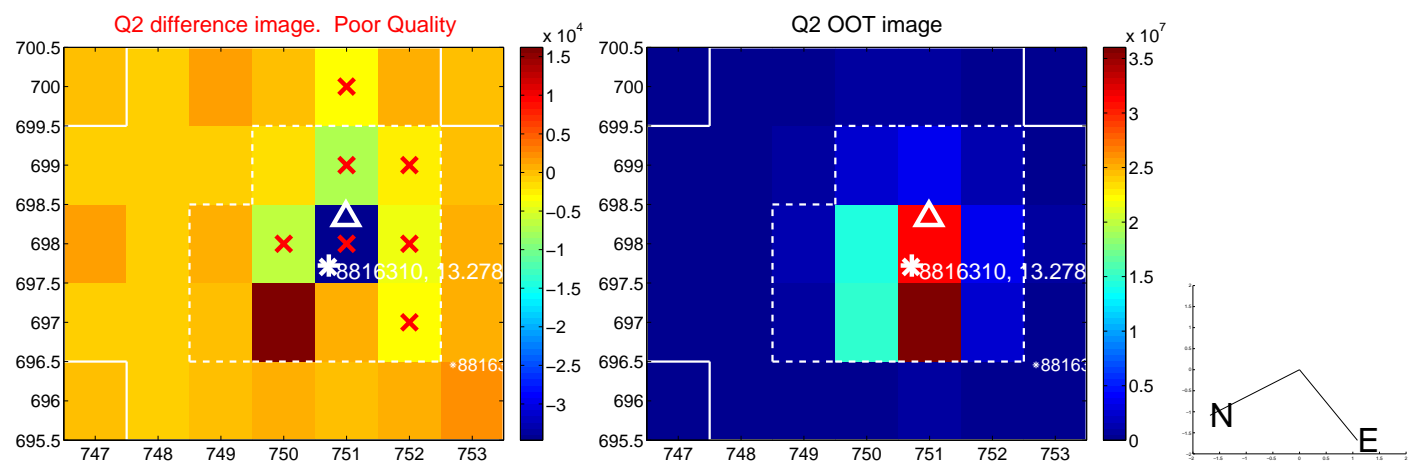
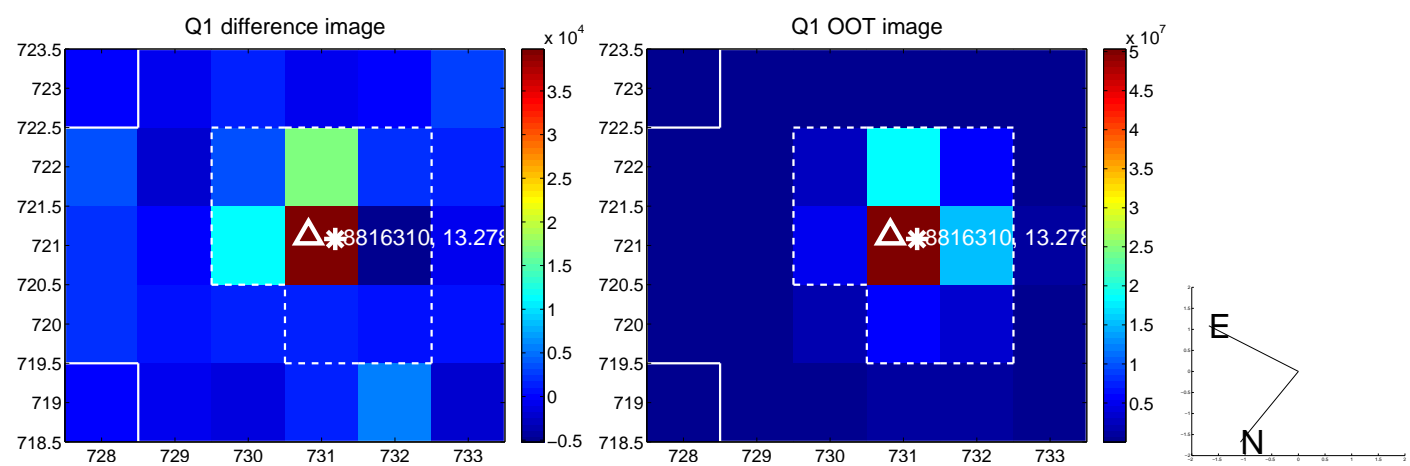
The direct PRF centroid is offset from the target star catalog position by about 0.07 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.473 \pm 0.806$	0.59	$-0.408 \pm 0.725$	$0.239 \pm 0.598$
PRF-fit source offset from KIC position	$0.457 \pm 0.806$	0.57	$-0.414 \pm 0.748$	$0.193 \pm 0.604$
photometric centroid source offset	$0.39 \pm 0.43$	0.91	$0.18 \pm 0.43$	$-0.34 \pm 0.43$

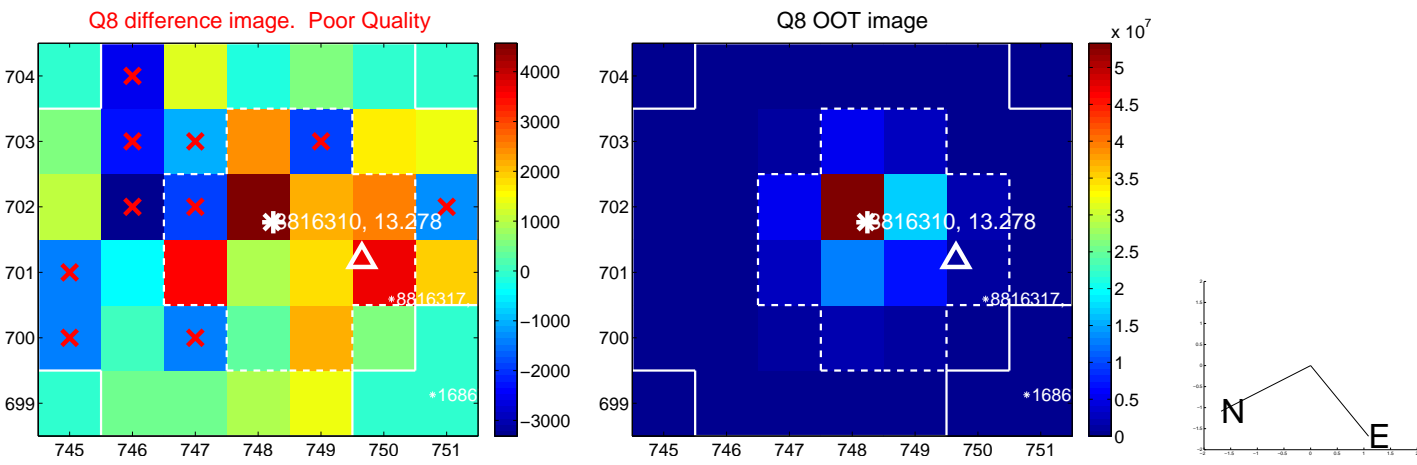
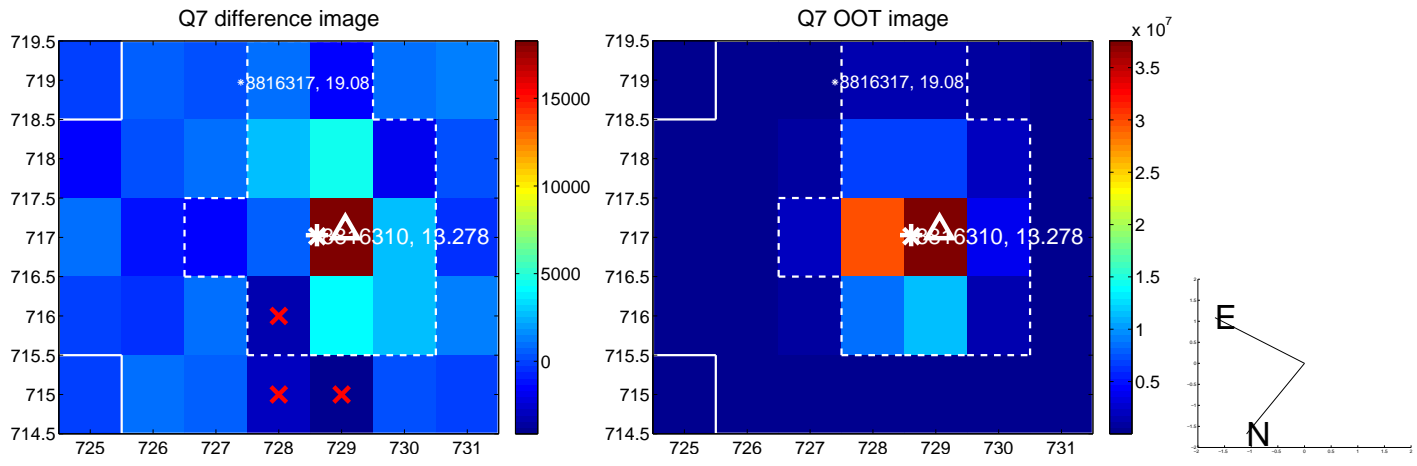
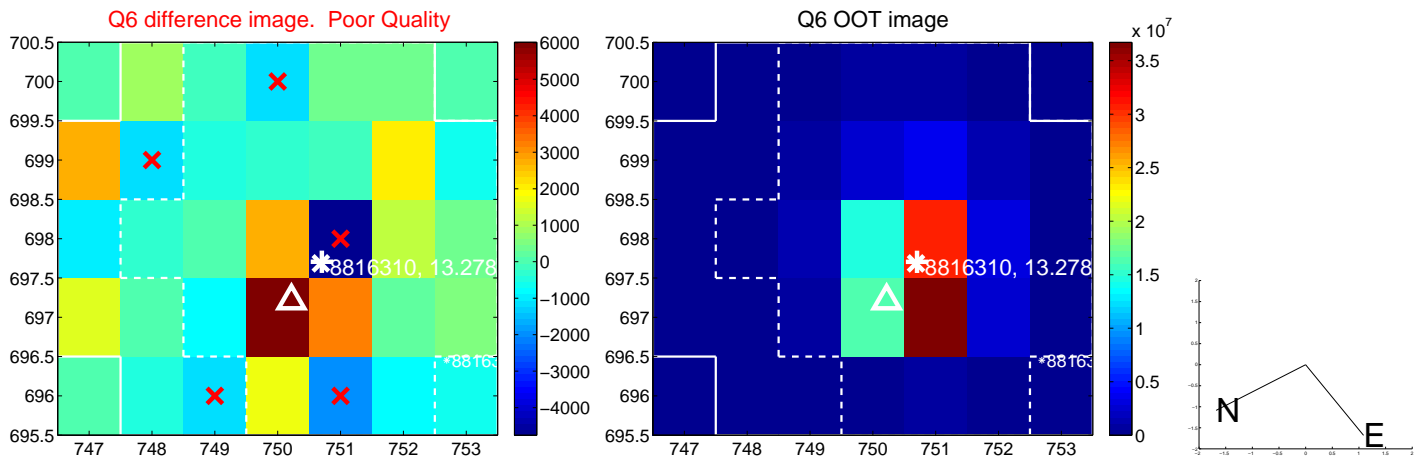
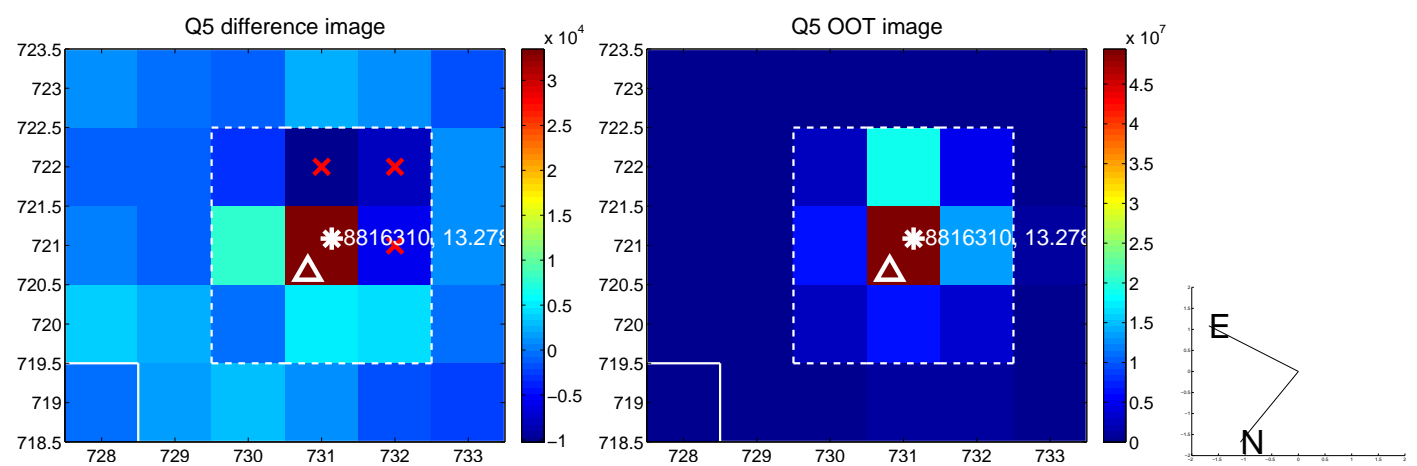


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses:** good quarterly centroid offsets; **Vermillion crosses:** bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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

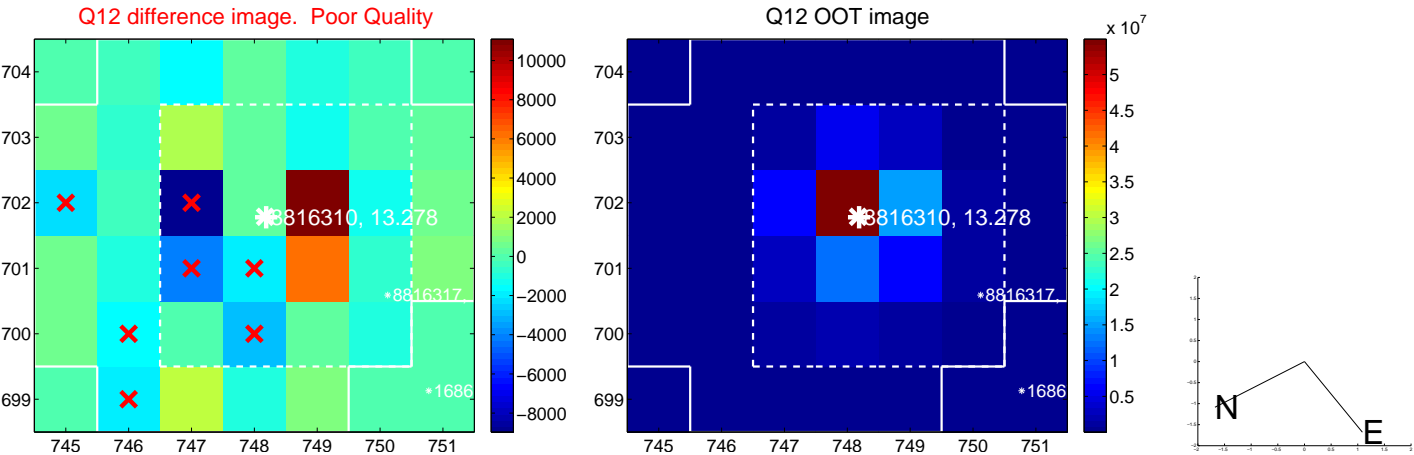
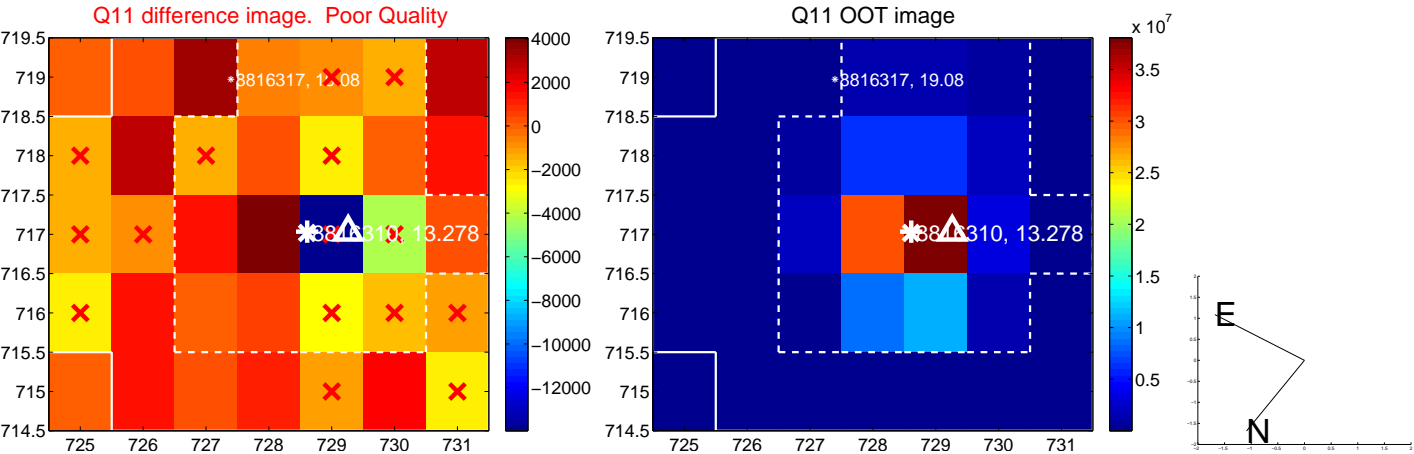
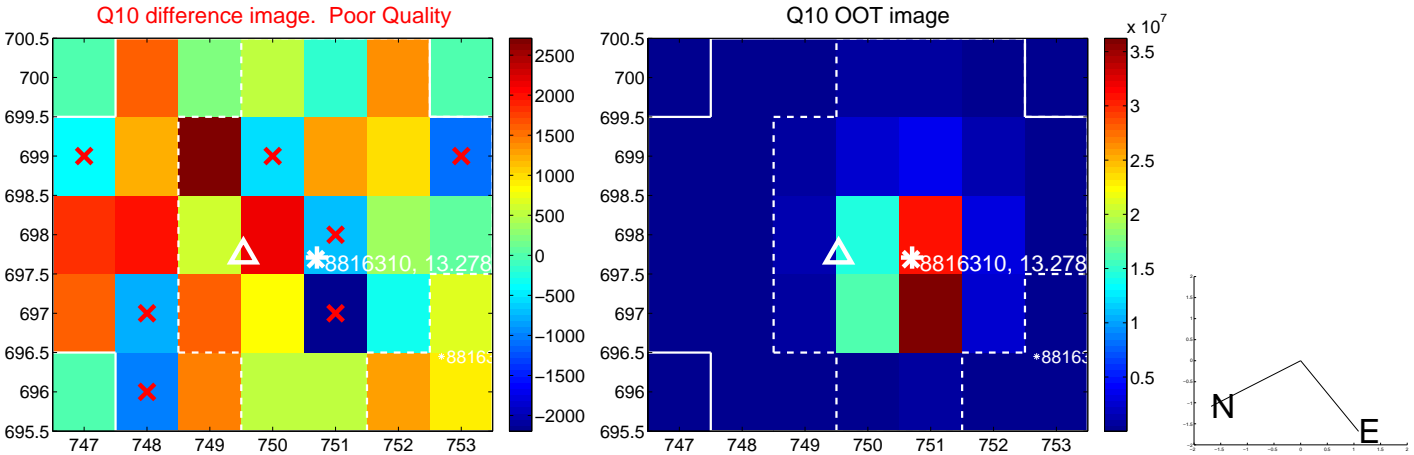
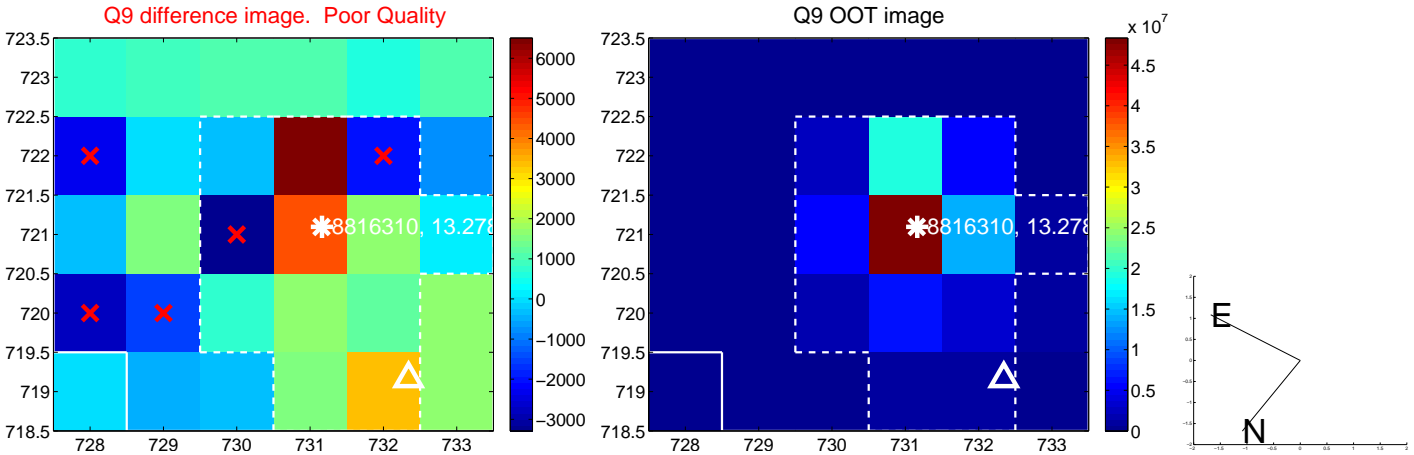
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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



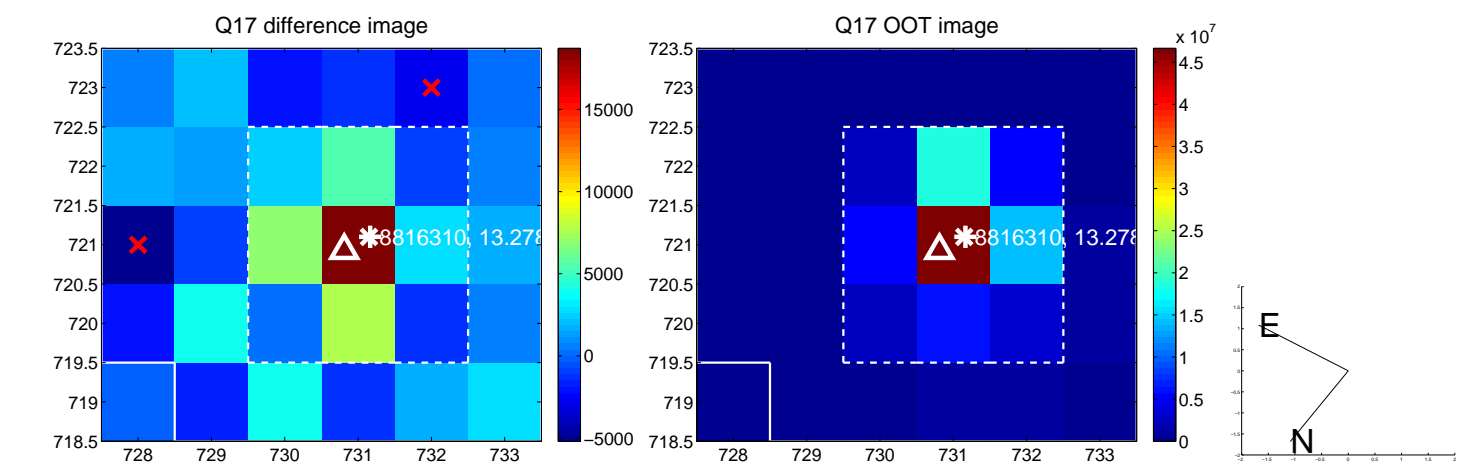
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



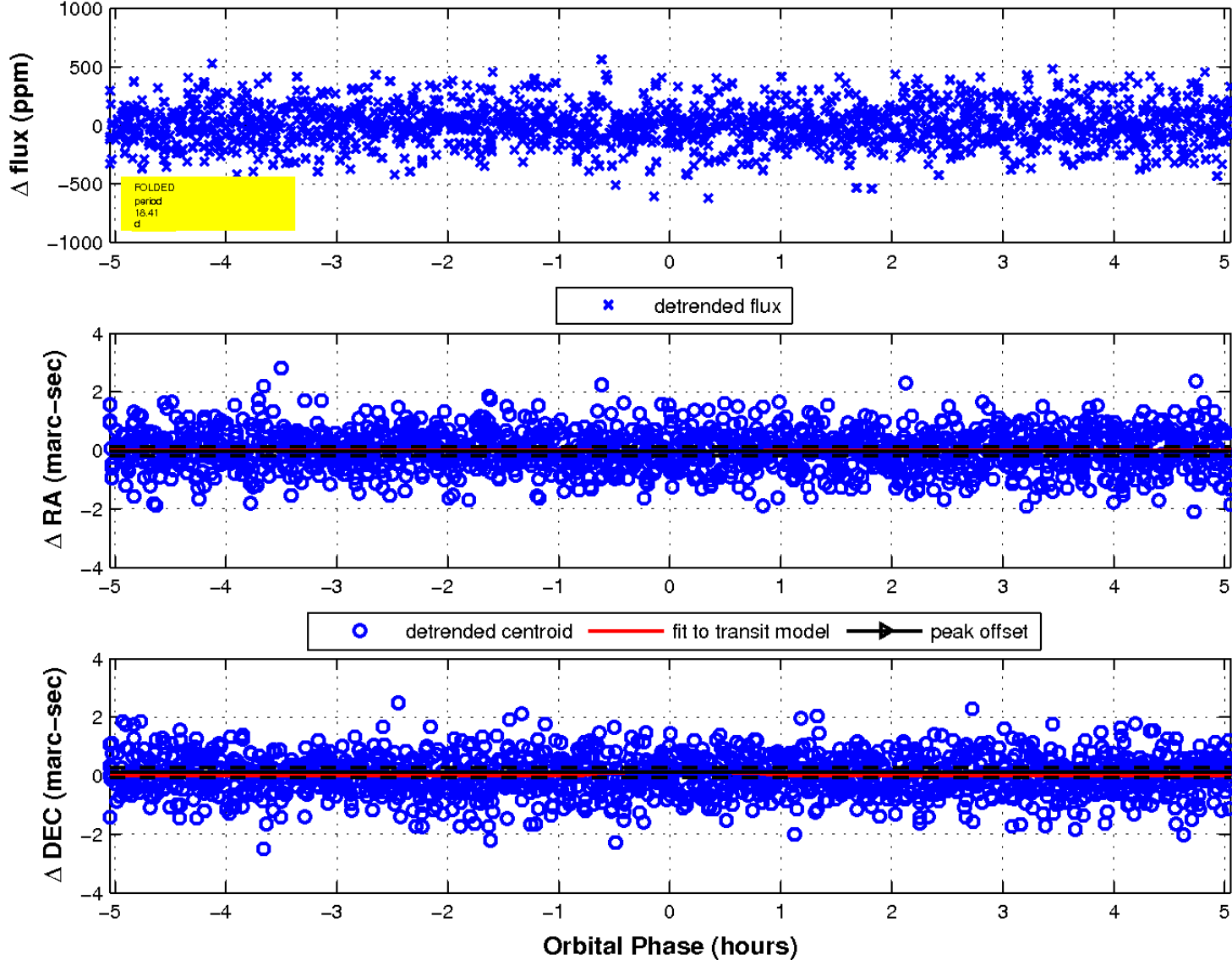




white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

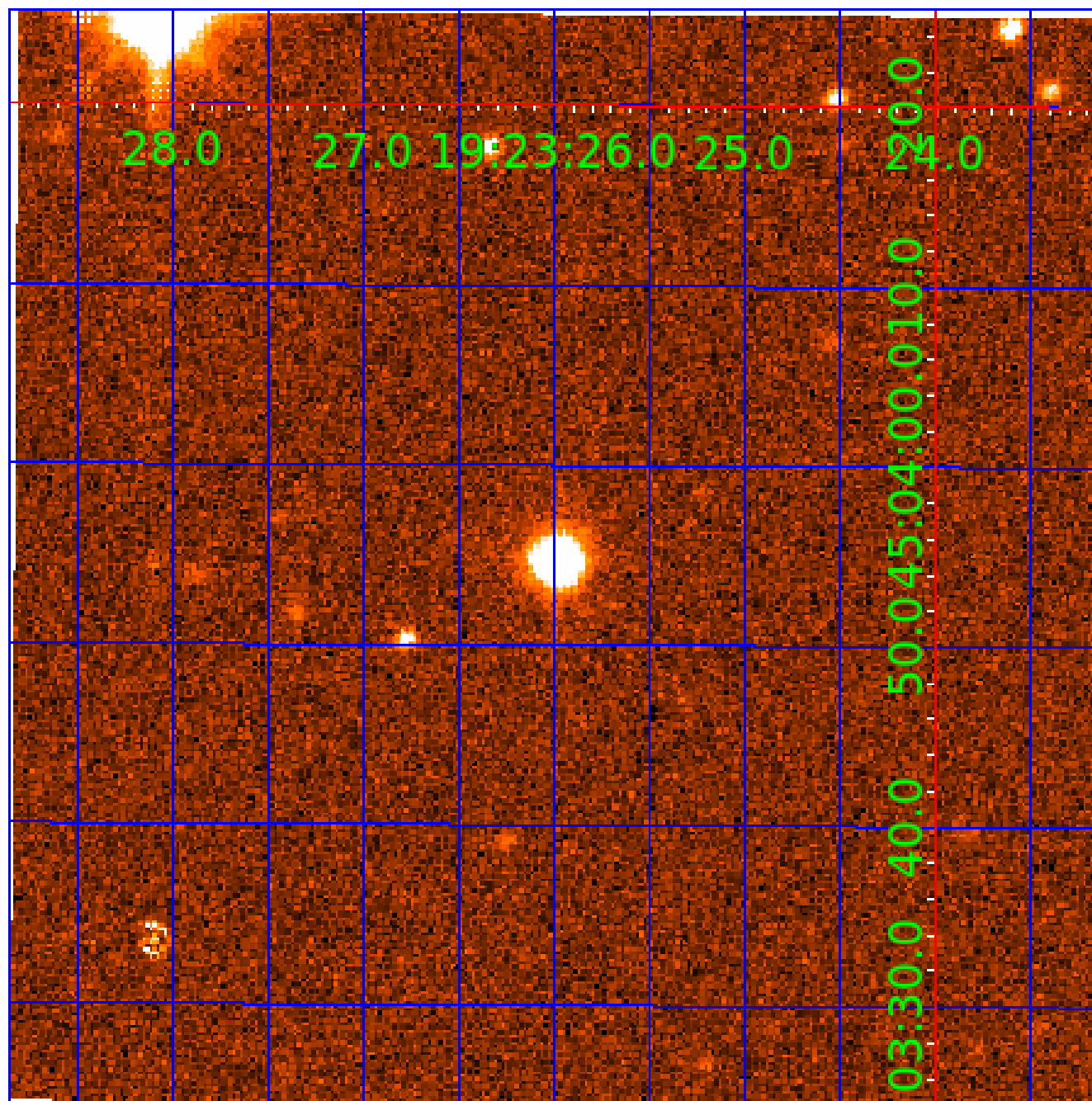


fluxWeightedCentroids, Planet 3 of 4



UKIRT Image

Declination



# KIC 008816310

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
008816310-01	OBS	No	1.778418	133.372527	43.2	5.138	12.5	9.9	1.63	7268	1.82	6466.61
008816310-02	OBS	No	1.778513	132.994912	28.6	13.482	13.7	11.5	1.63	7268	0.89	6466.15
008816310-03	OBS	No	18.408321	149.891981	340.6	1.687	22.4	18.9	1.63	7268	3.32	286.66
008816310-04	OBS	No	20.754171	135.005786	441.9	2.500	12.7	-1.0	1.63	7268	3.49	244.29

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
008816310-01	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_SKYE_ZUMA_TRACKER—LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—MOD_NONUNIQ_ALT
008816310-02	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_SKYE_ZUMA_TRACKER—LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—SAME_NTL_PERIOD
008816310-03	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_SKYE—TRANS_GAPPED—LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—MOD_NONUNIQ_ALT
008816310-04	OBS	FP	0.00	1	0	1	0	INDIV_TRANS_RUBBLE—TRANS_GAPPED—LPP_DV—LPP_ALT—MOD_NONUNIQ_ALT—MOD_TER_ALT—MOD_POS_ALT—CENT_NOFITS—HALO_GHOST

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

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

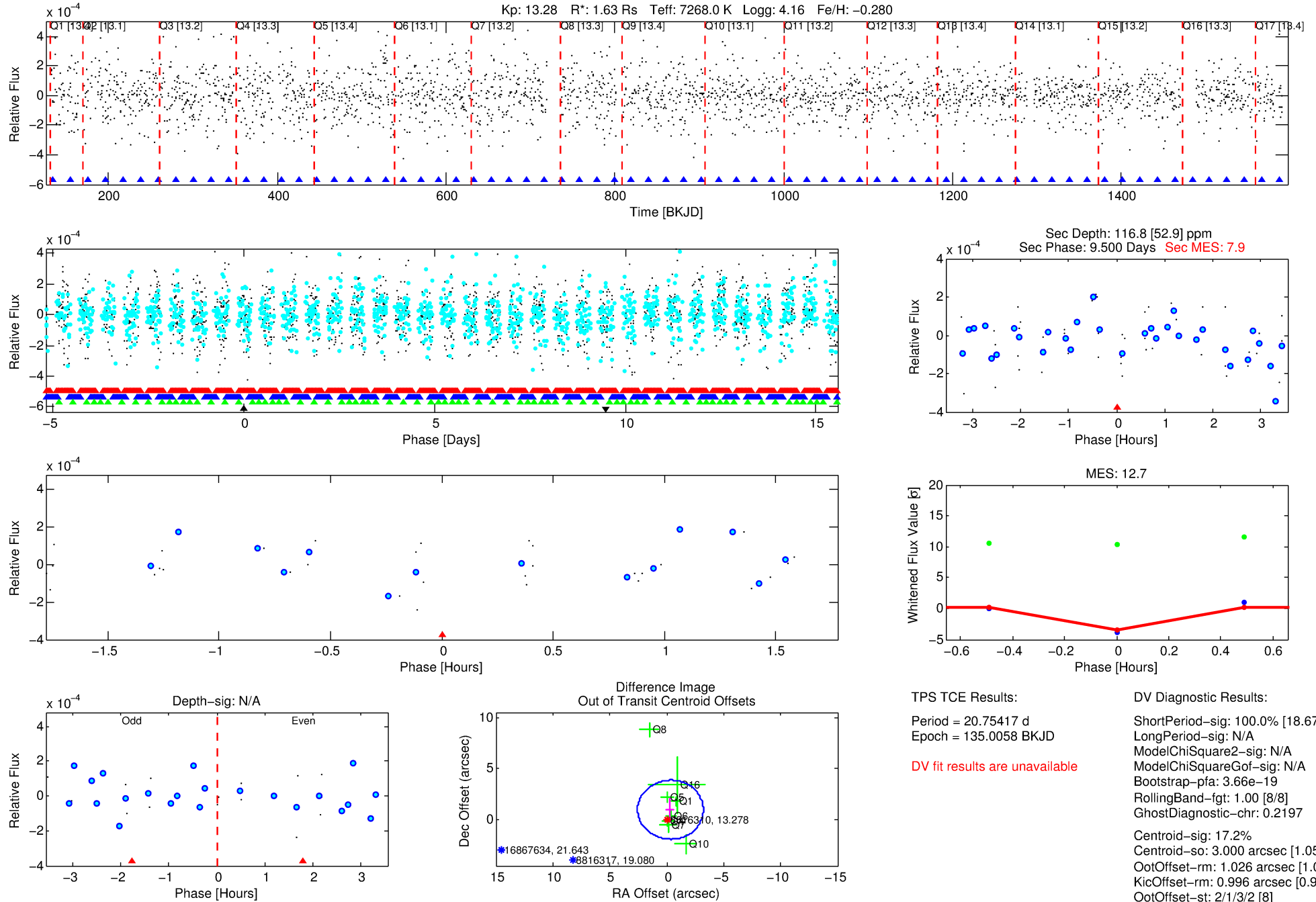
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

Ephemeris Match Information For 008816310-04

No Significant Match Found

# DV One-Page Summary

KIC: 8816310 Candidate: 4 of 4 Period: 20.754 d

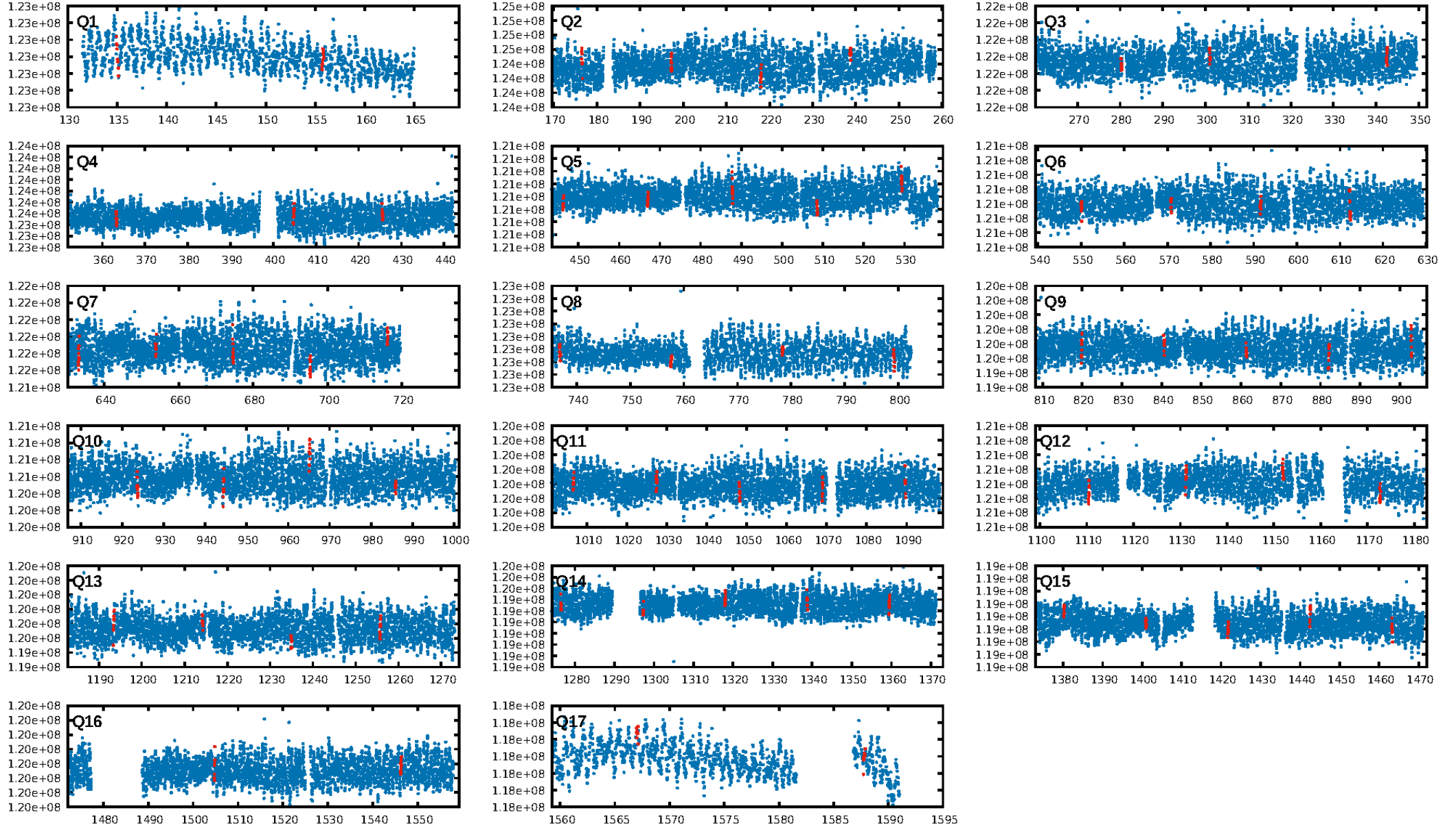


Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 31-Jan-2016 19:06:14 Z

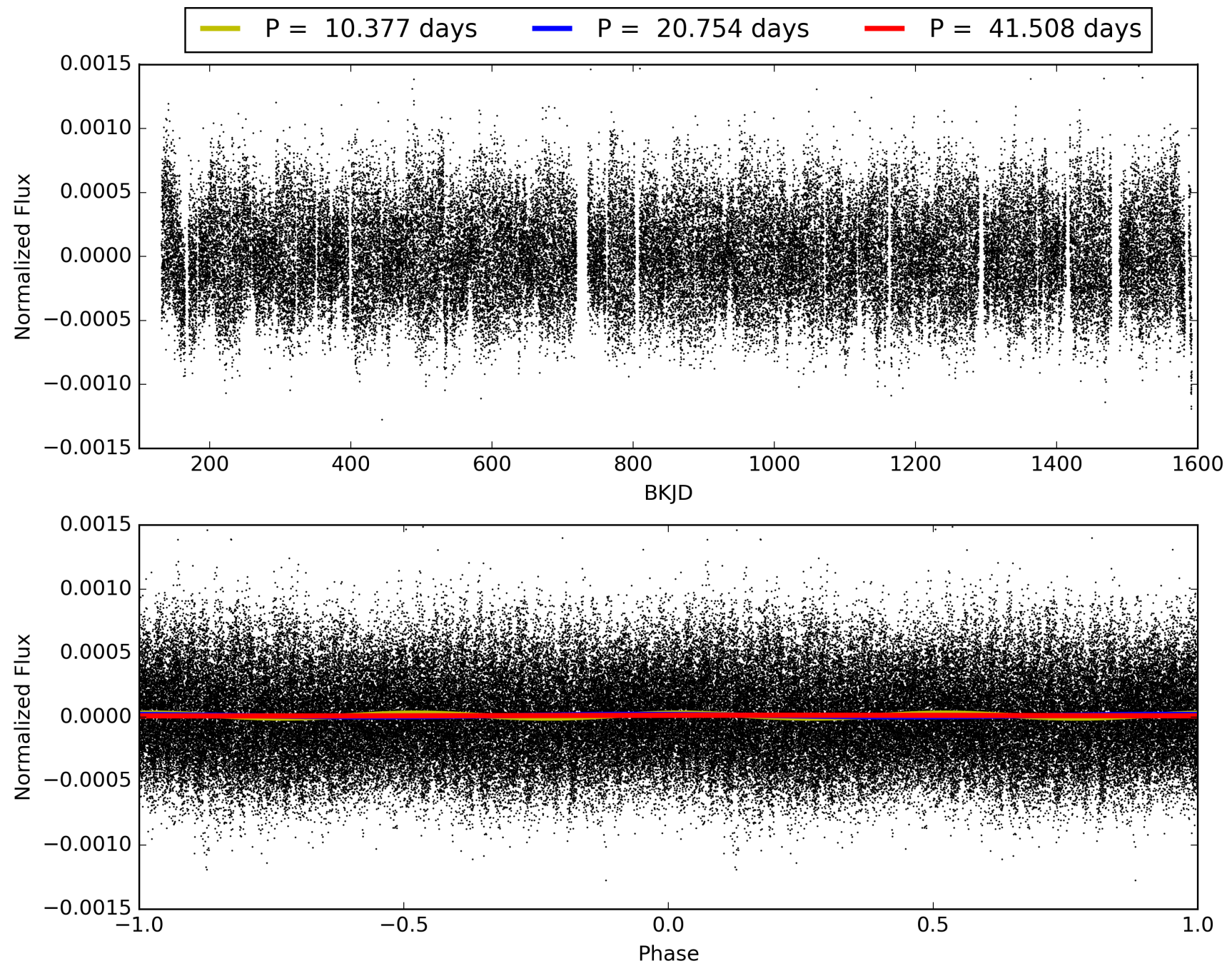
This Data Validation Report Summary was produced in the Kepler Science Operations Center Pipeline at NASA Ames Research Center



# TCE 008816310-04, PDC Light Curves

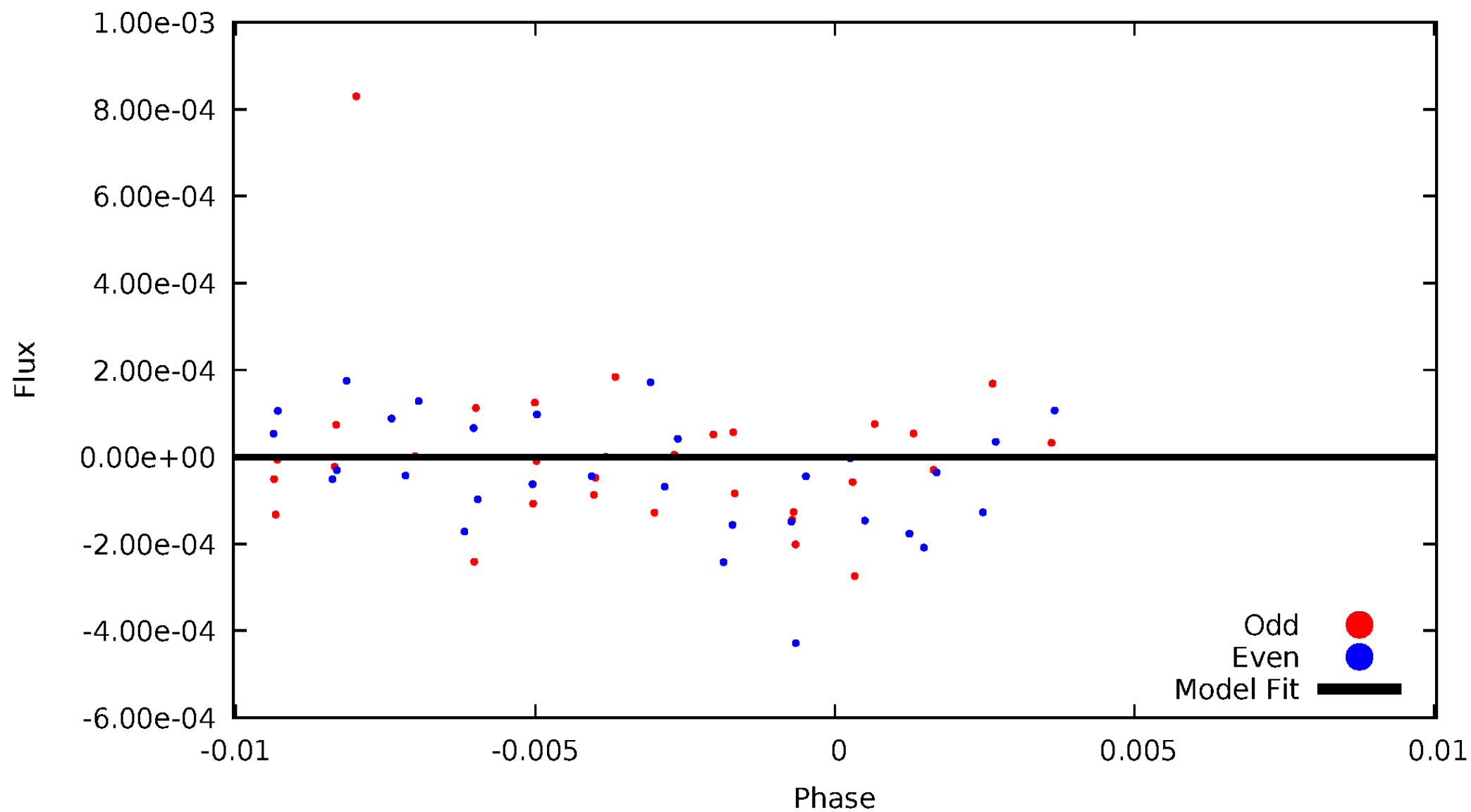


TCE 008816310-04



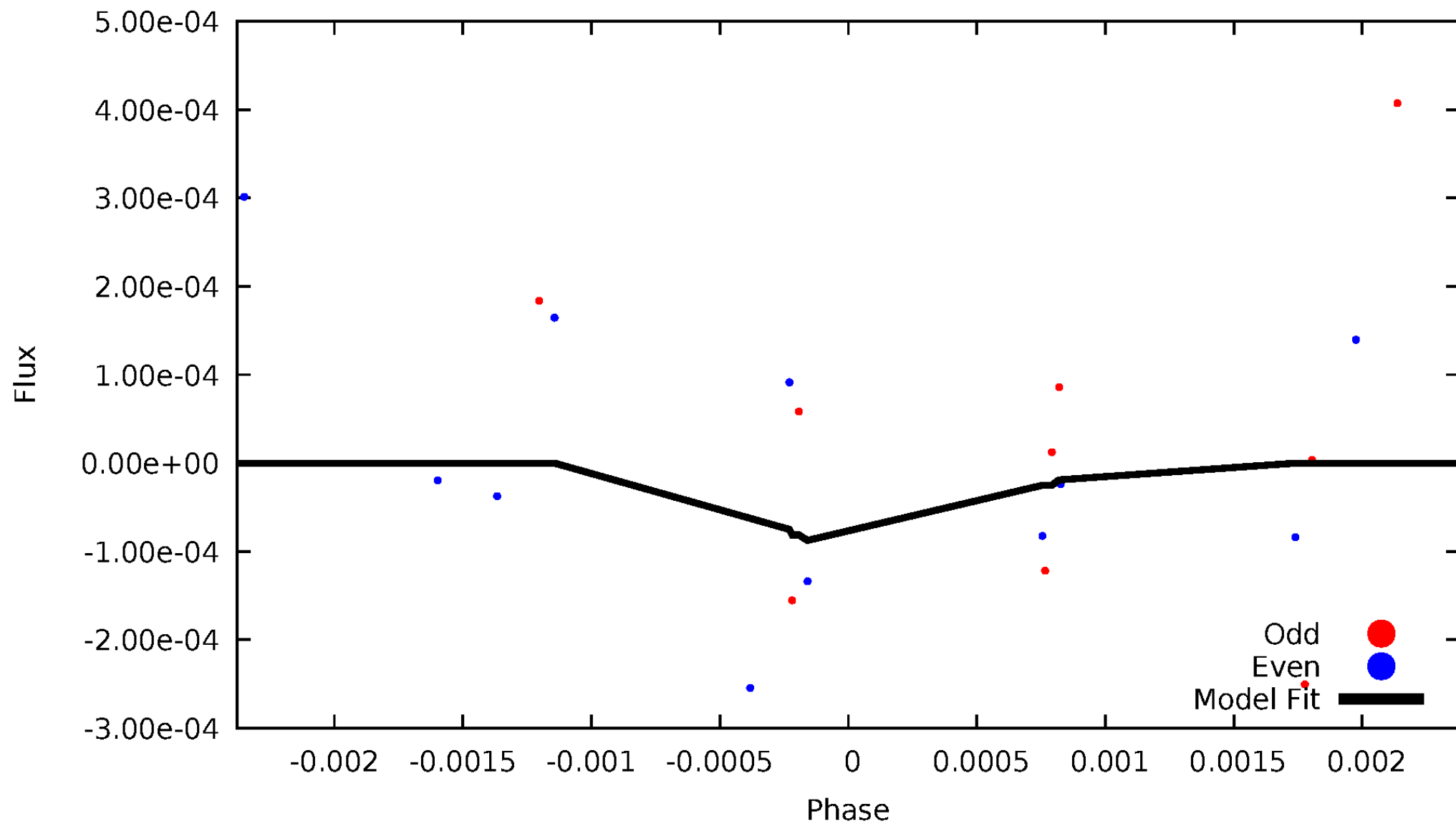
# DV Odd/Even

TCE 008816310-04



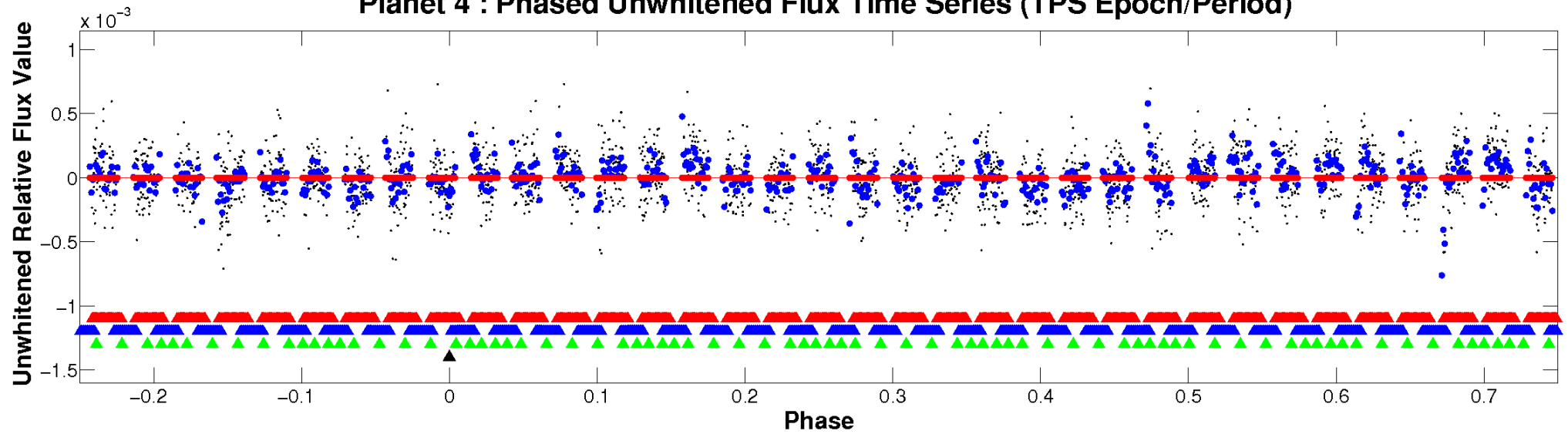
# ALT Odd/Even

TCE 008816310-04

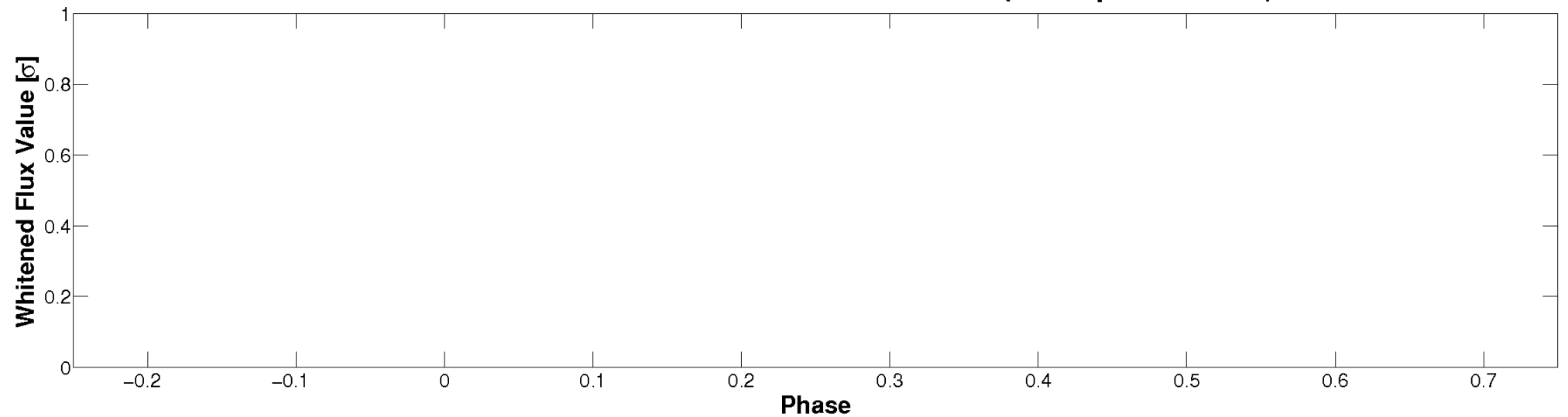


# Non-Whitened Vs. Whitened Light Curve

**Planet 4 : Phased Unwhitened Flux Time Series (TPS Epoch/Period)**

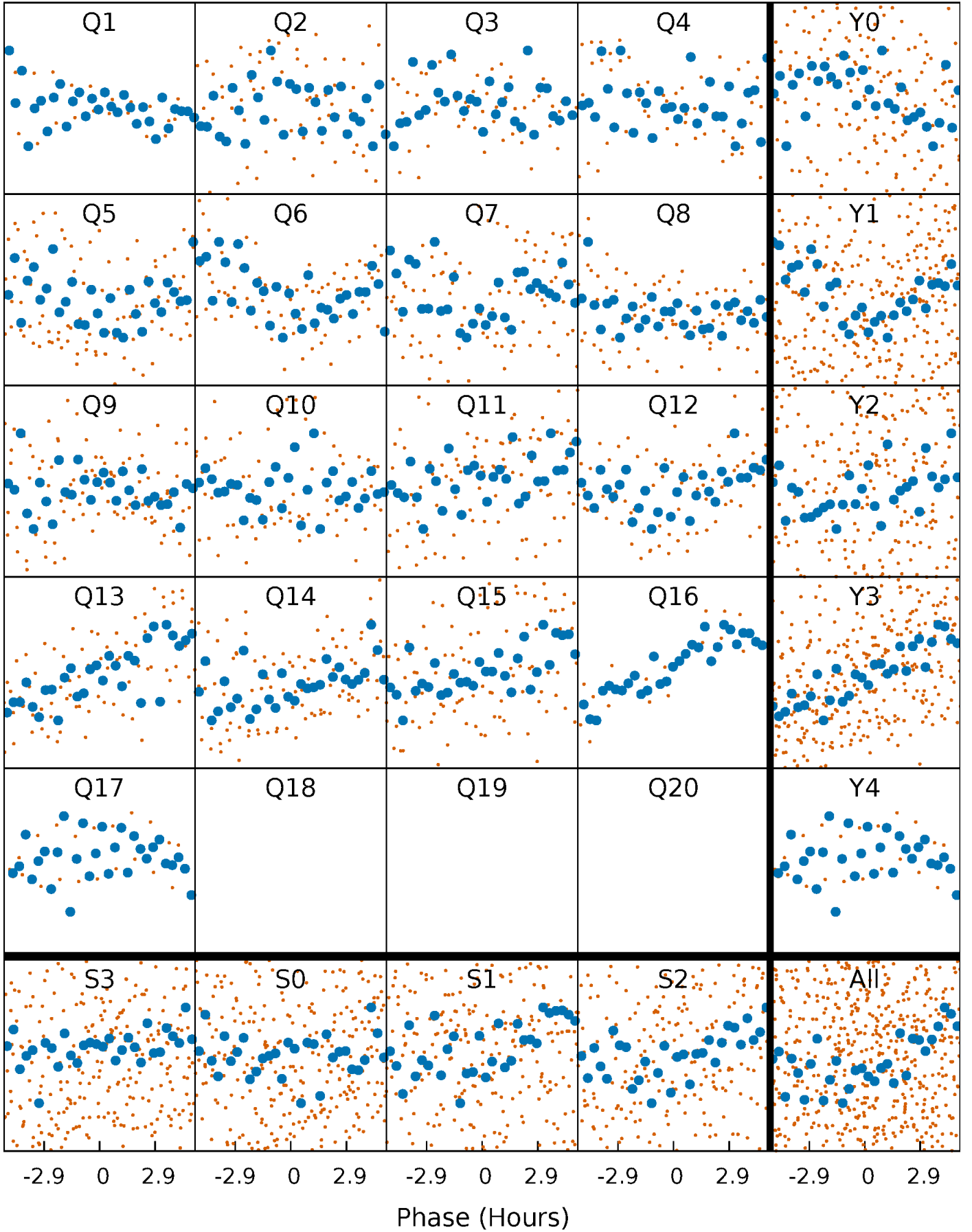


**Planet 4 : Phased Whitened Flux Time Series (TPS Epoch/Period)**



# PDC Quarter-Phased Transit Curves

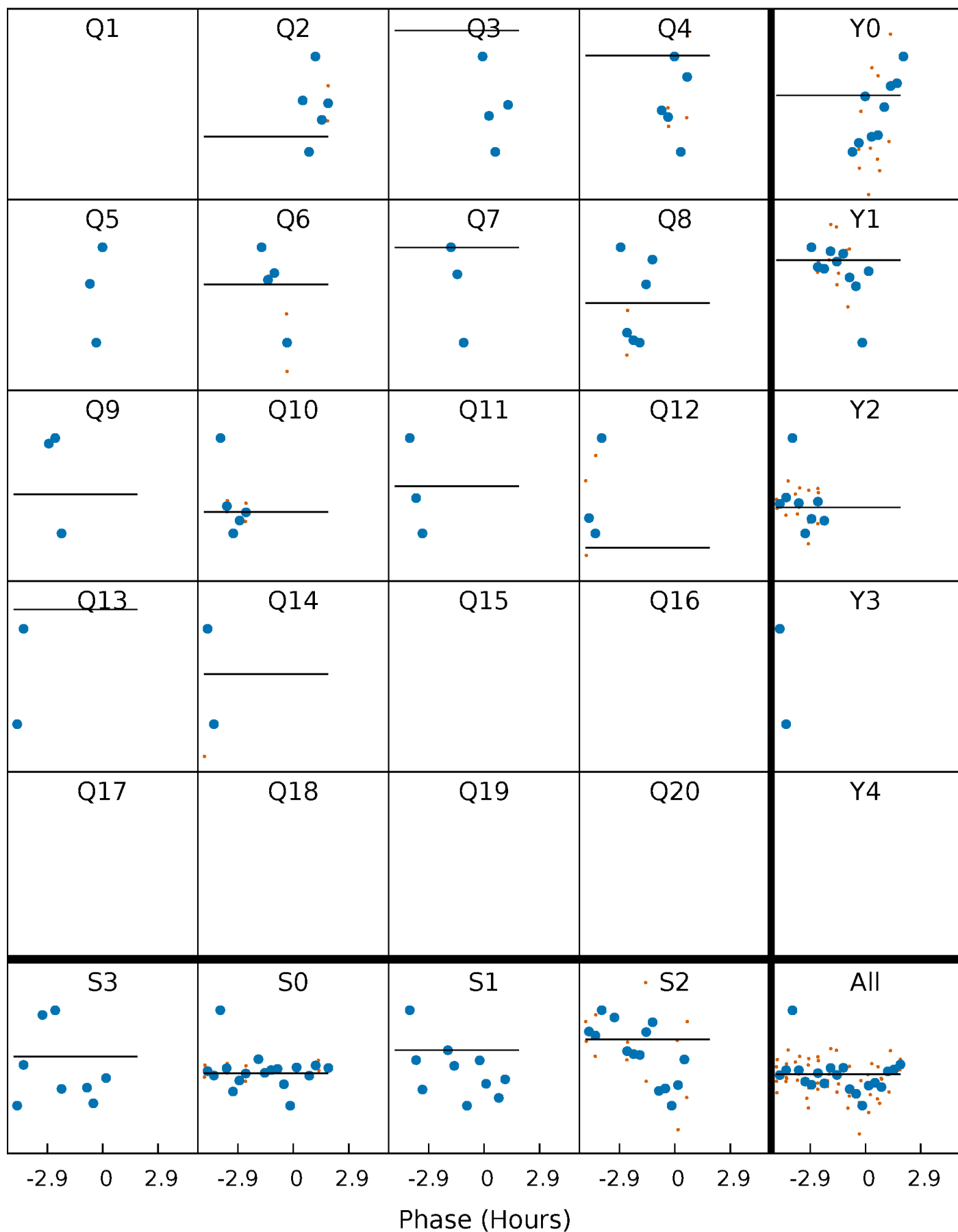
TCE 008816310-04   P= 20.754171 Days    $T_0=135.005786$  (BKJD)





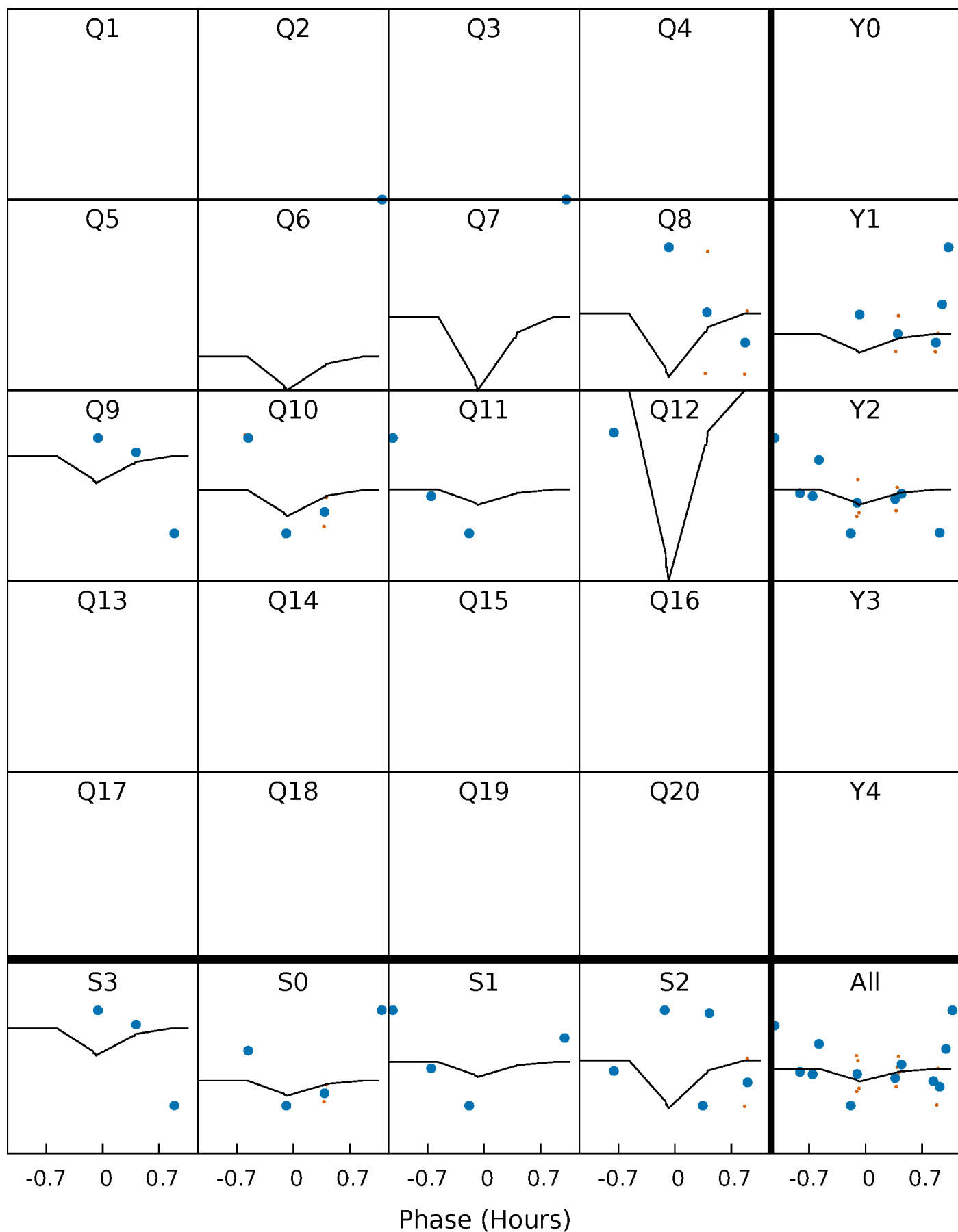
# DV Quarter-Phased Transit Curves

TCE 008816310-04 P= 20.754171 Days  $T_0=135.005786$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

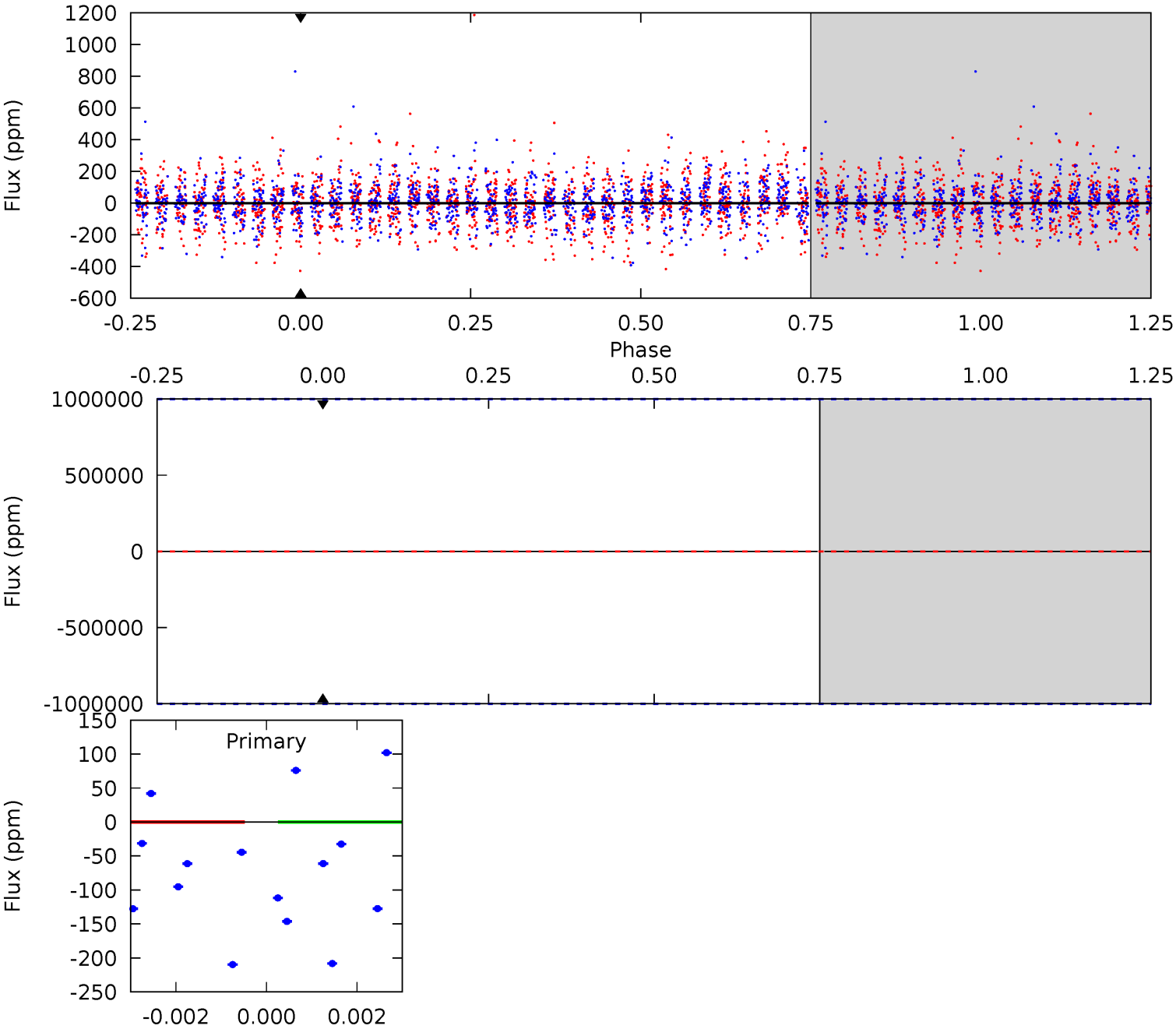
TCE 008816310-04 P= 20.754171 Days  $T_0=134.885376$  (BKJD)



# DV Model-Shift Uniqueness Test

008816310-04, P = 20.754171 Days, E = 114.251615 Days

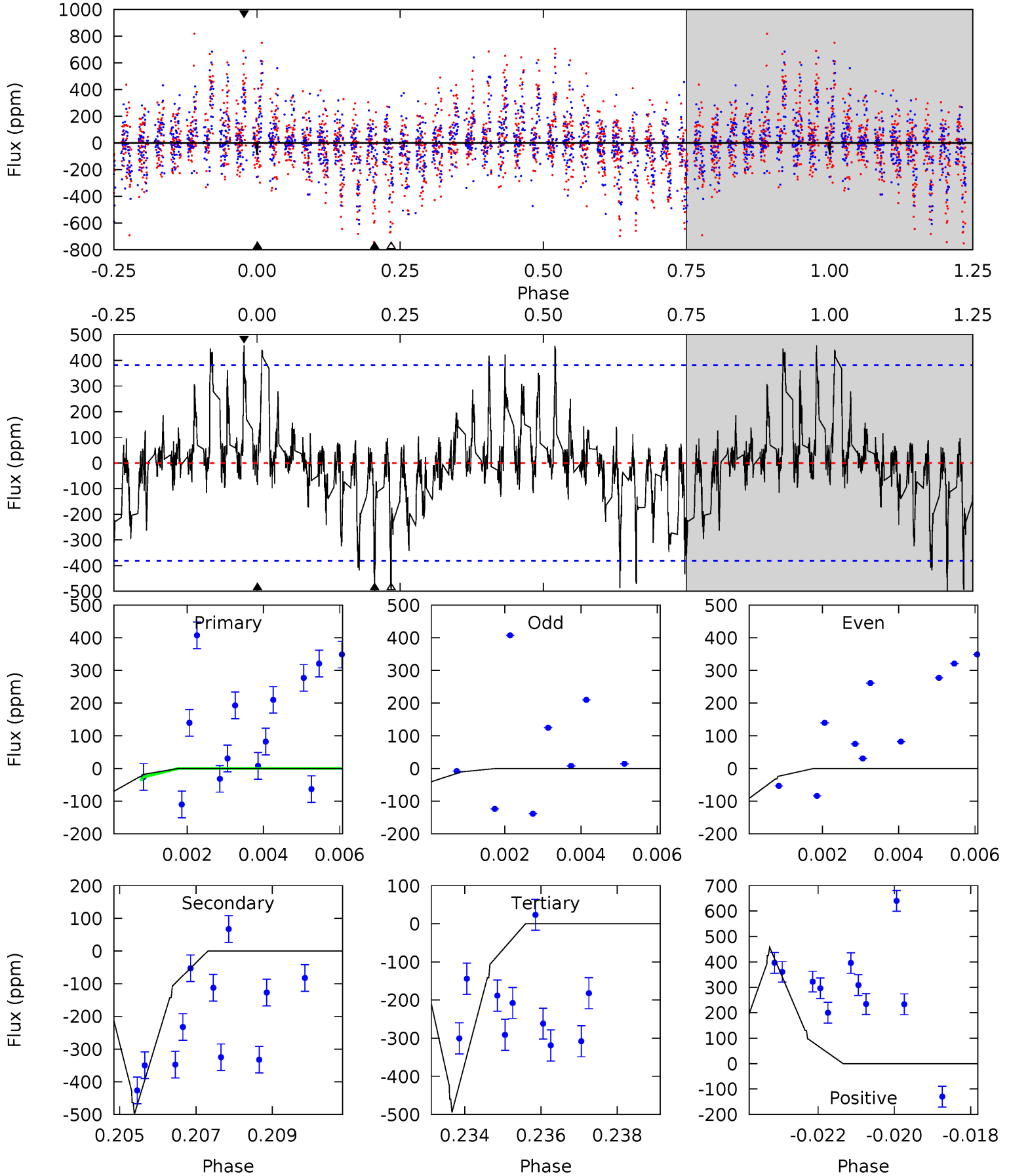
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
0	0	0	0	1.00	1.00	1.00	0	0	0	0	0	0	0	0



# Alt Model-Shift Uniqueness Test

008816310-04, P = 20.754171 Days, E = 114.131205 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
1.20	6.98	6.91	6.40	5.33	3.09	1.92	-5.72	-5.20	0.06	0.58	0.46	1.35	0.48	0.32



### Stellar Parameters For KIC 008816310

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R (R_{\odot})$	$M(M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$7268^{+228}_{-304}$	$4.157^{+0.148}_{-0.181}$	$-0.280^{+0.250}_{-0.350}$	$1.634^{+0.521}_{-0.347}$	$1.399^{+0.204}_{-0.226}$	$0.451^{+0.387}_{-0.220}$
	+3%/-4%	+4%/-4%	+89%/-125%	+32%/-21%	+15%/-16%	+86%/-49%
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 008816310-04 / KOI

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{max} (K)$	$T_{obs} (K)$	$A_{obs}$
DV	$0 \pm 1000000$	$12.91^{+13.66}_{-8.87}$	$1417^{+113}_{-92}$	$3598^{+36213}_{-35534}$	$18^{+18164}_{-11332}$
Alt.	$-499 \pm 72$	$12.61^{+14.48}_{-8.93}$	$1415^{+112}_{-98}$	$4265^{+3234}_{-933}$	$47^{+514}_{-37}$

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

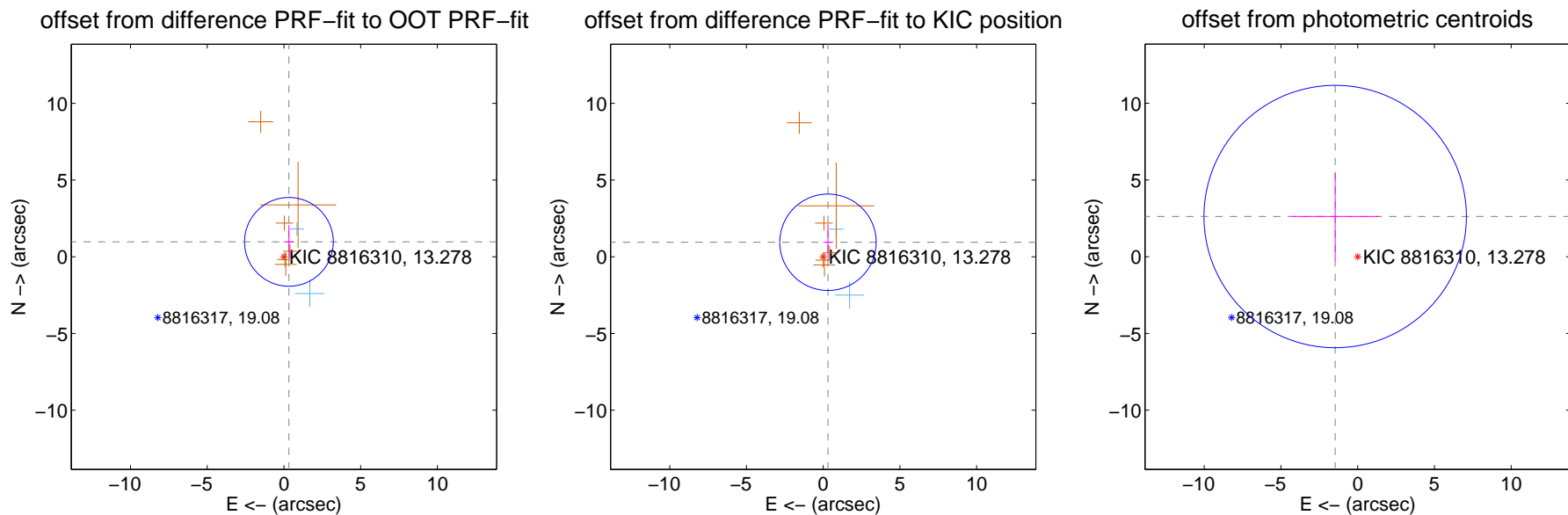
## DV Centroid Data

Supplemental centroid analysis for 008816310-04. Kepler magnitude: 13.28. Transit SNR -1.00

There are 2 quarters with good PRF difference image offsets

The direct PRF centroid is offset from the target star catalog position by about 0.10 arcsec

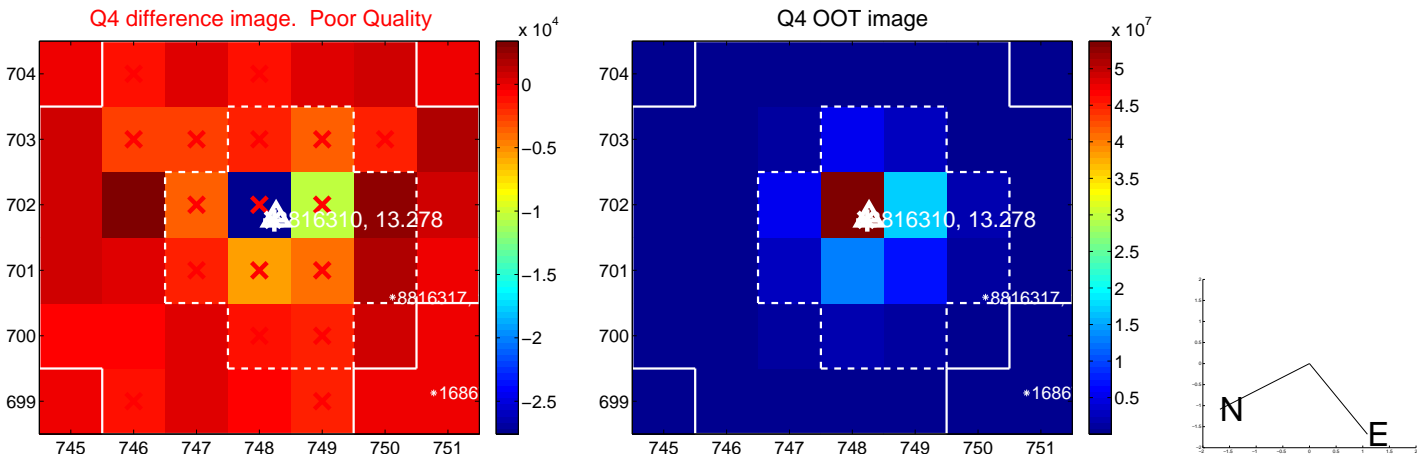
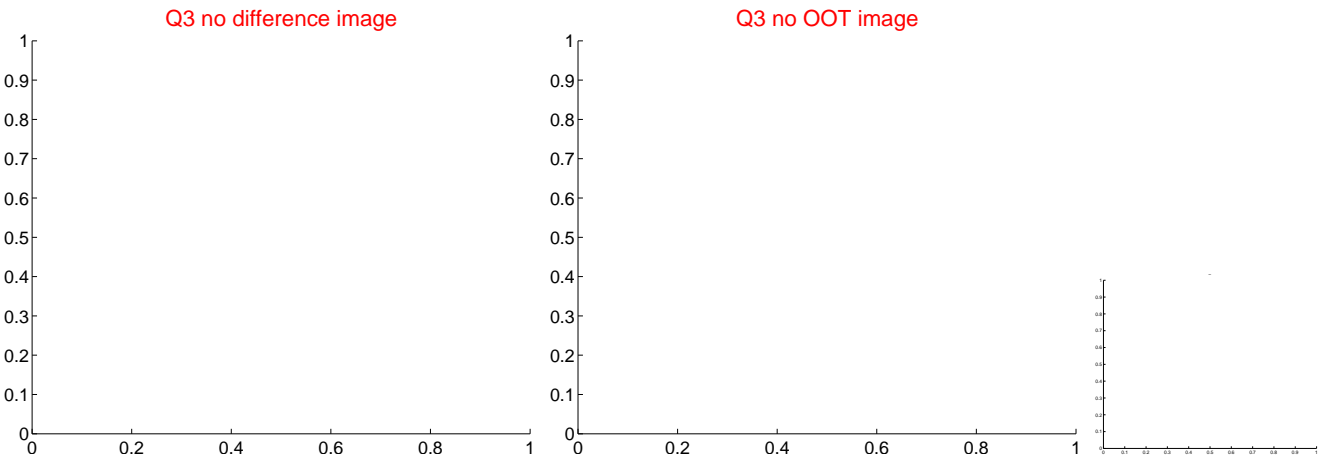
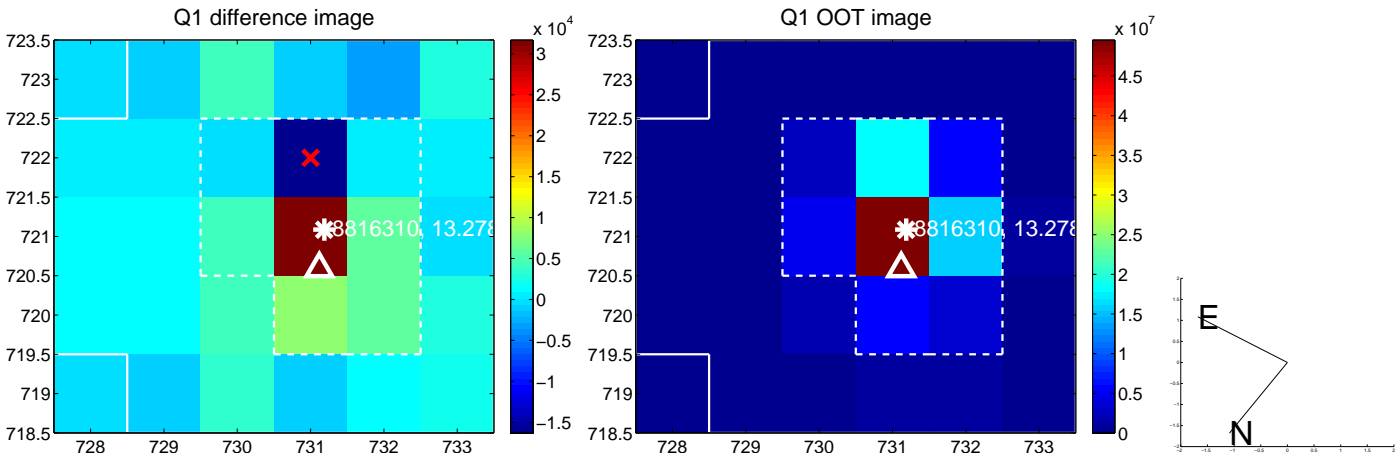
	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$1.026 \pm 0.964$	1.06	$-0.326 \pm 0.329$	$0.973 \pm 1.098$
PRF-fit source offset from KIC position	$0.996 \pm 1.047$	0.95	$-0.313 \pm 0.308$	$0.945 \pm 1.183$
photometric centroid source offset	$3.00 \pm 2.85$	1.05	$1.47 \pm 2.84$	$2.62 \pm 2.85$



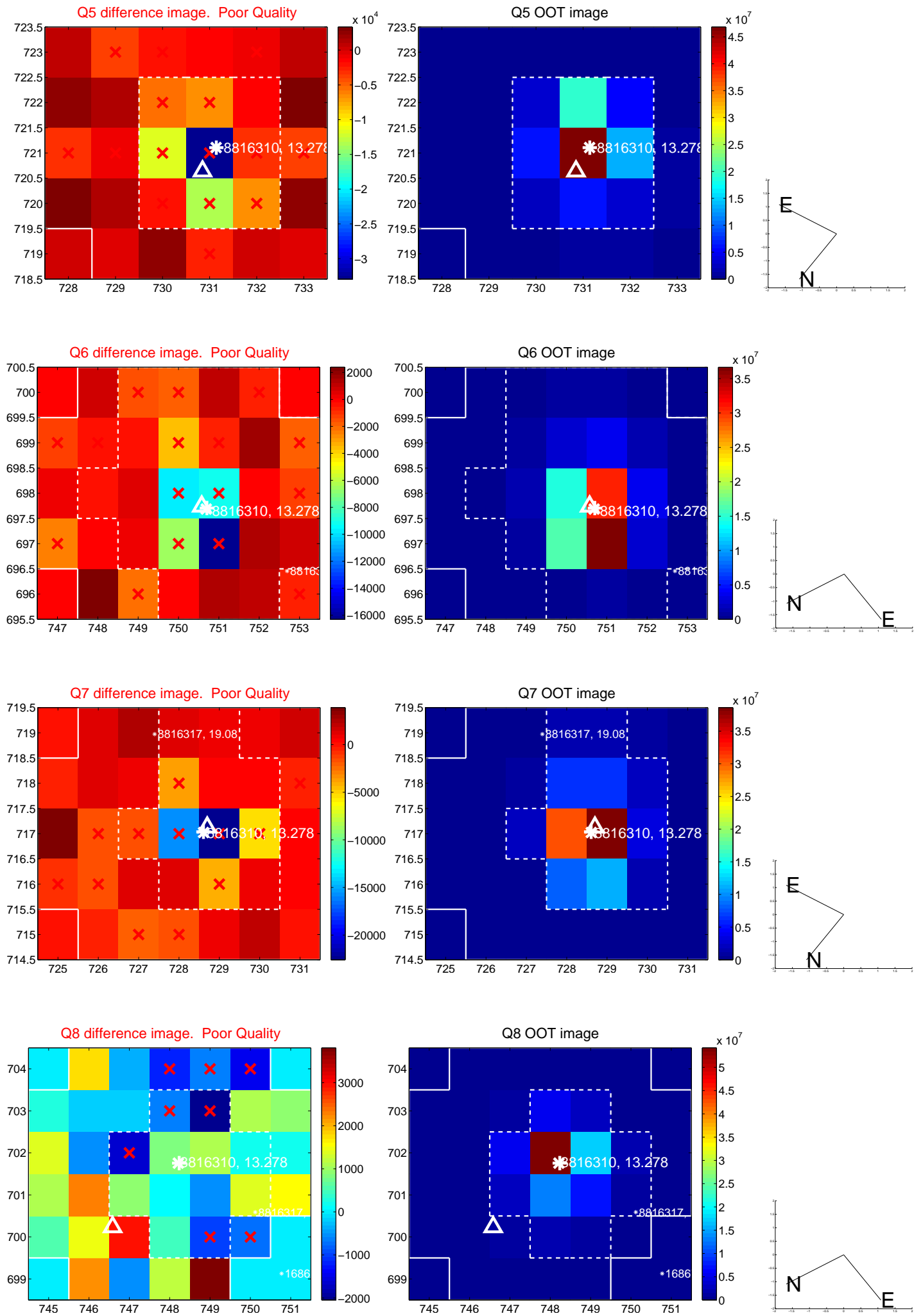
Centroid source offsets from the target star reconstructed from PRF and photometric centroids. Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: three-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



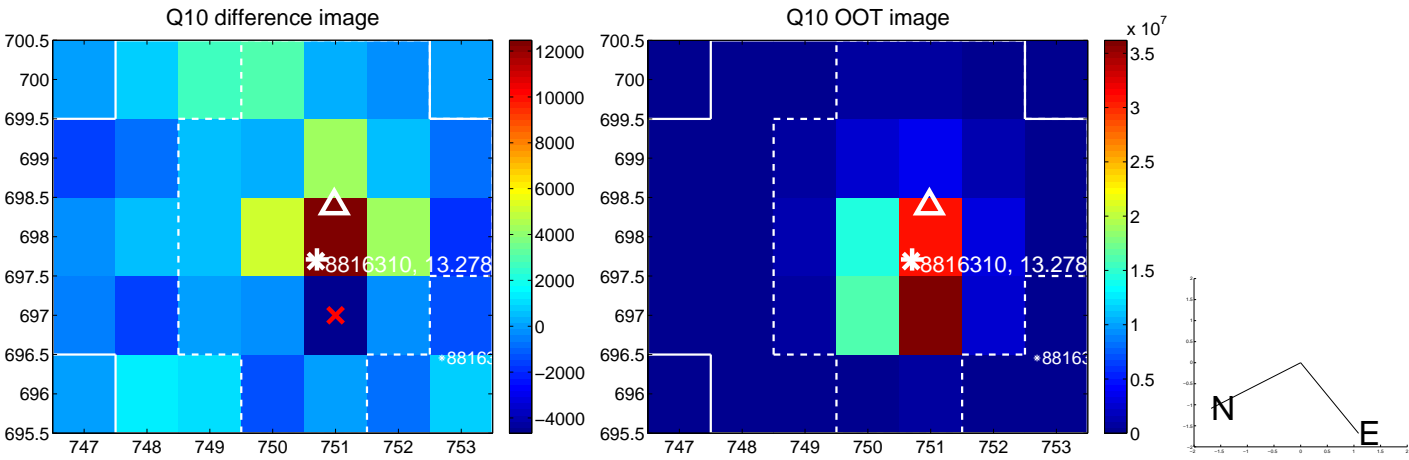
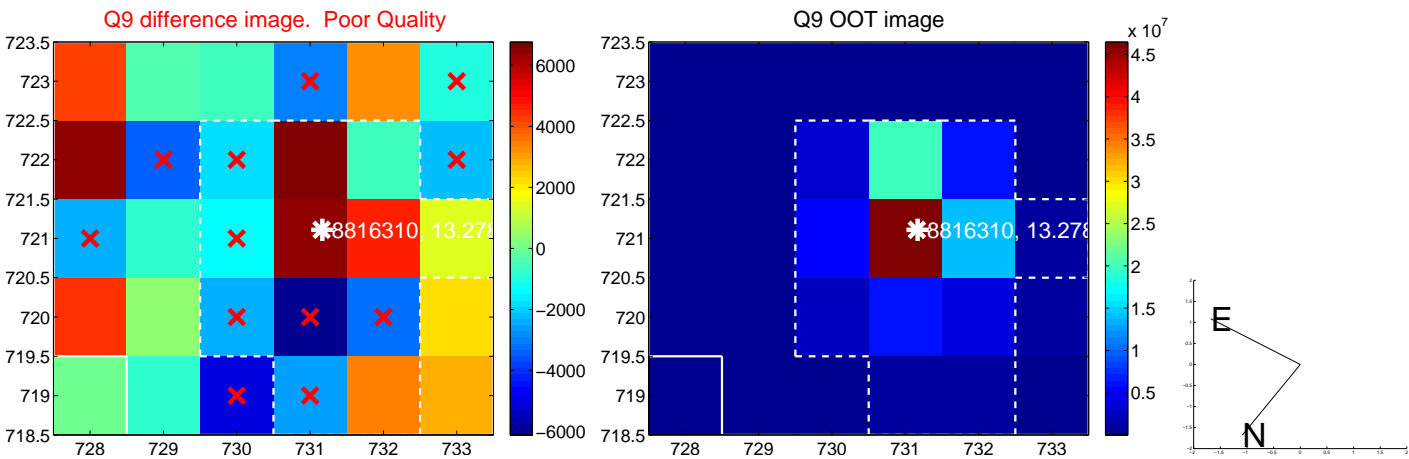
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



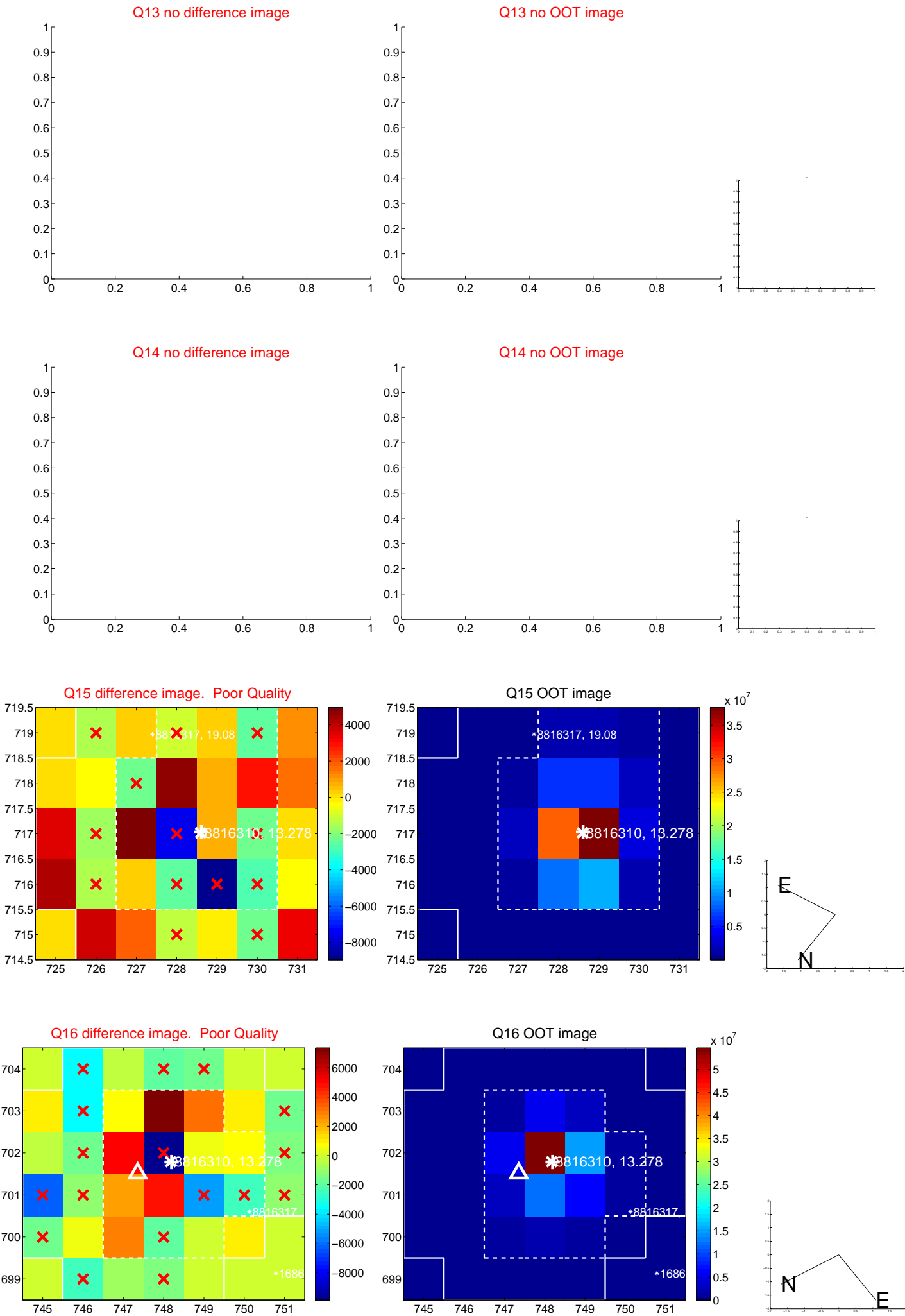
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



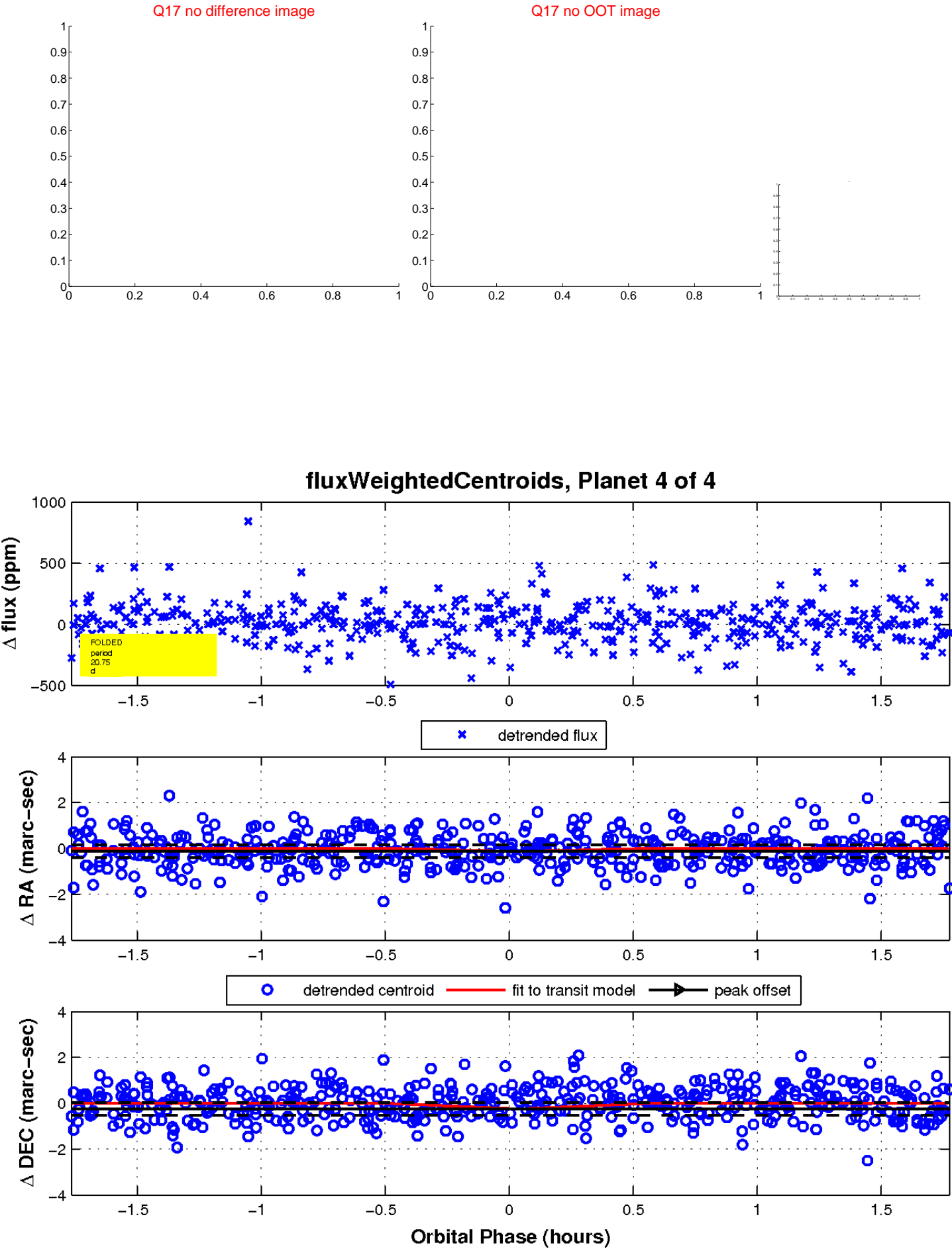
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

