

# KIC 010019643

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
010019643-01	OBS	0471.01	21.347361	150.387624	615.9	4.108	39.4	43.9	1.07	5395	3.14	41.71
010019643-02	OBS	0471.02	7.811039	132.300753	129.0	3.298	13.9	14.4	1.07	5395	1.42	159.38

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
010019643-01	OBS	PC	1.00	0	0	0	0	NO_COMMENT
010019643-02	OBS	PC	1.00	0	0	0	0	NO_COMMENT

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

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

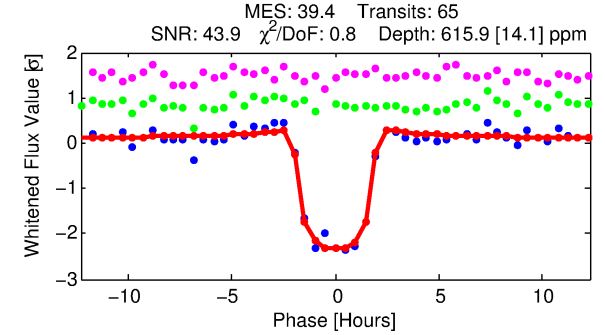
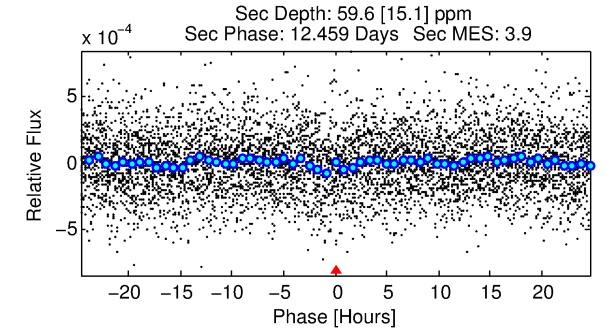
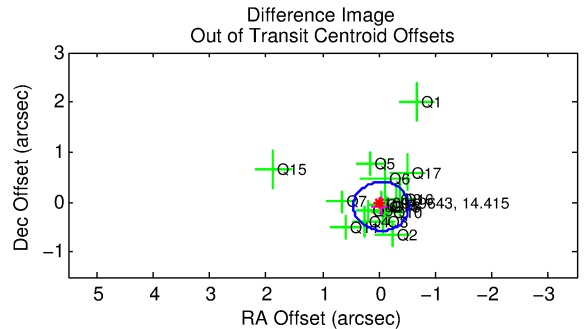
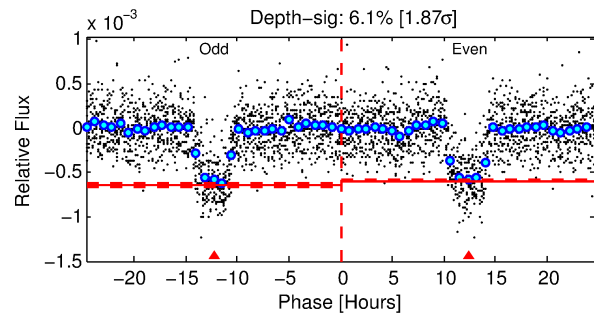
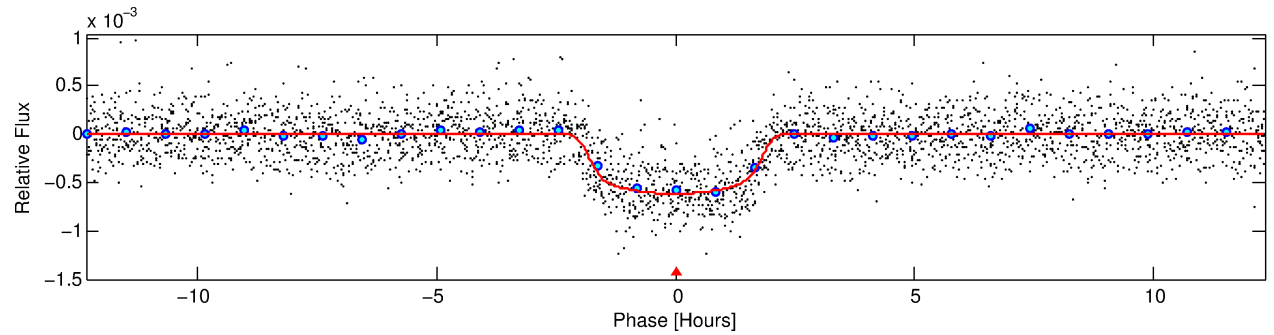
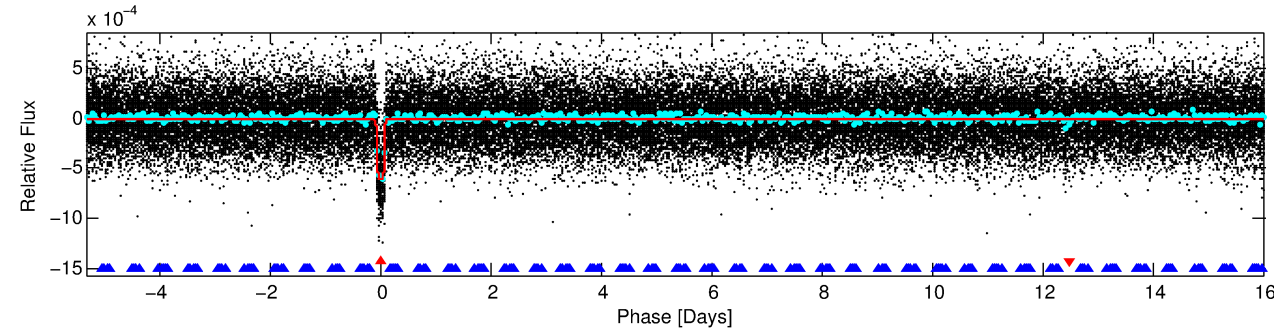
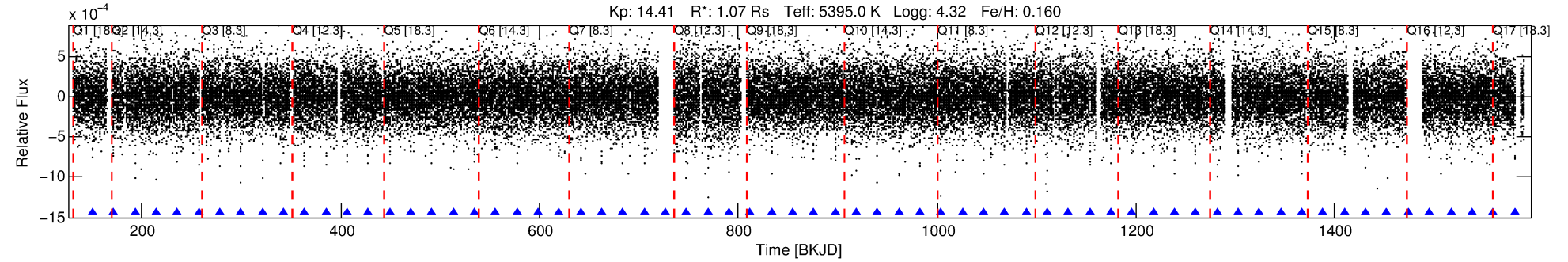
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 010019643-01

No Significant Match Found

# DV One-Page Summary

KIC: 10019643 Candidate: 1 of 2 Period: 21.347 d  
KOI: K00471.01 Name: Kepler-163c Corr: 0.966



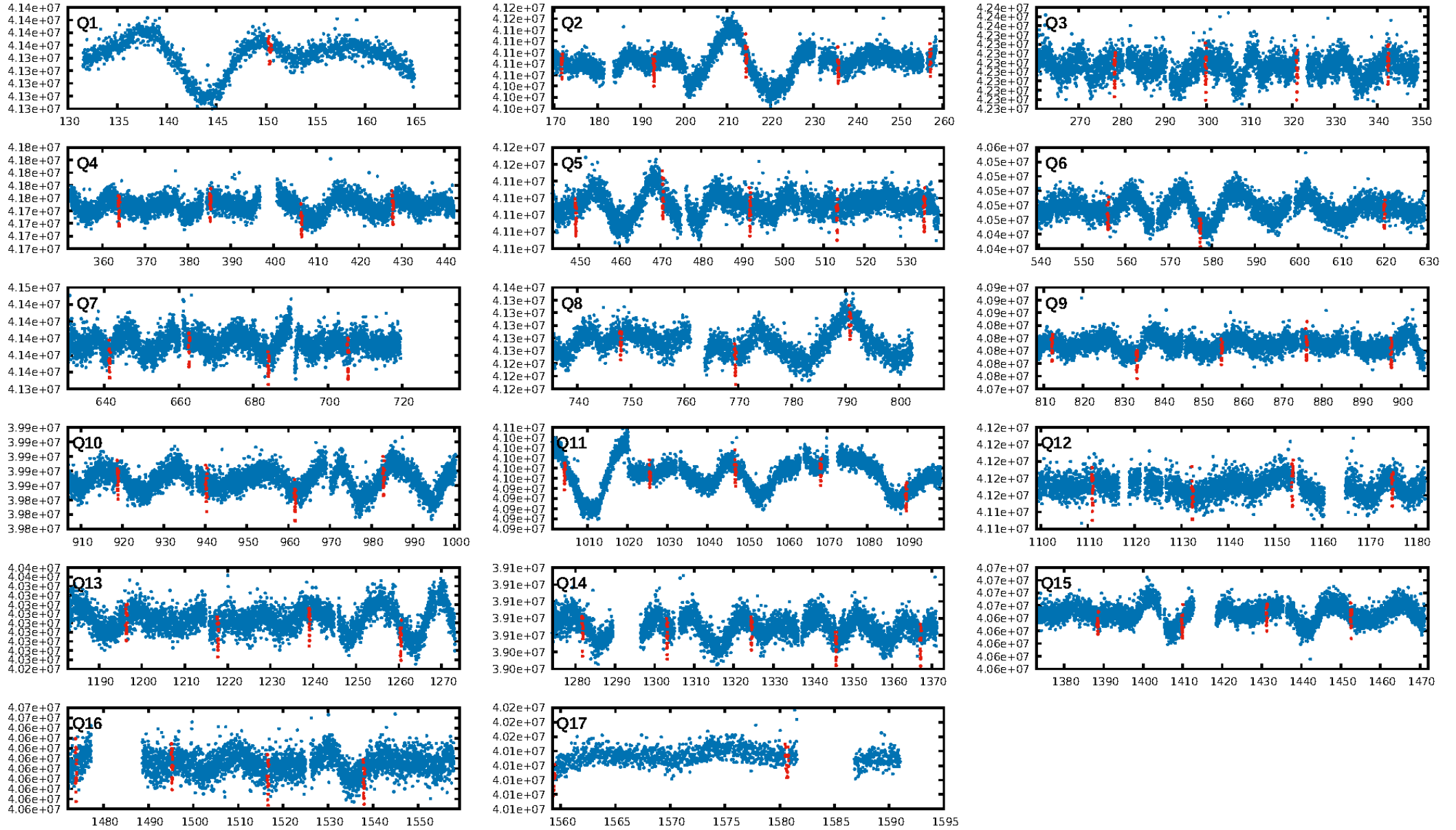
## DV Fit Results:

Period = 21.34736 [0.00005] d  
Epoch = 150.3876 [0.0019] BKJD  
Rp/R\* = 0.0269 [0.0018]  
a/R\* = 21.05 [5.61]  
b = 0.88 [0.07]  
Seff = 41.71 [11.19]  
Teff = 648 [43] K  
Rp = 3.14 [0.57] Re  
a = 0.1445 [0.0235] AU  
Ag = 69.45 [26.96] [2.54σ]  
Teffp = 2892 [212] K [10.38σ]

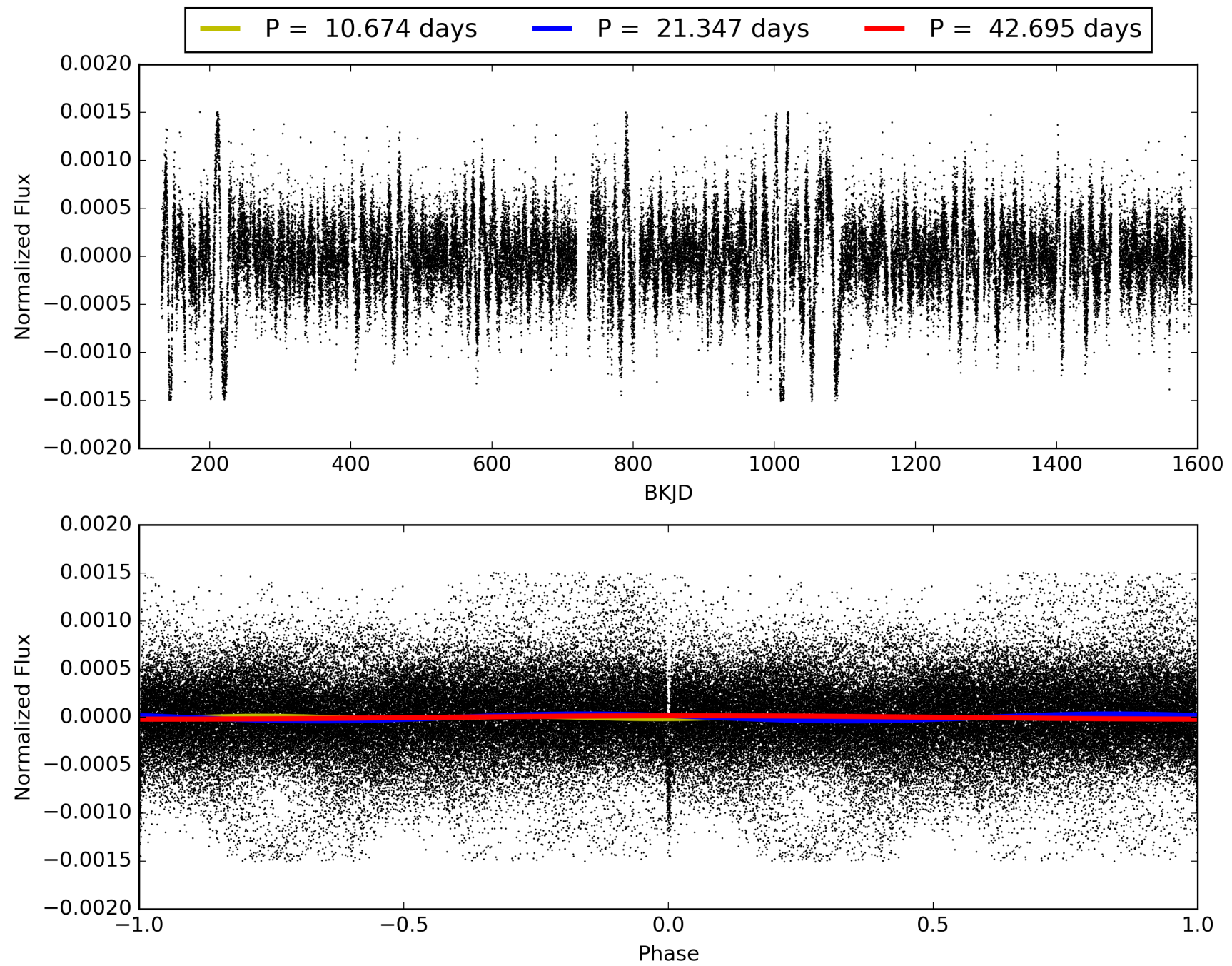
## DV Diagnostic Results:

ShortPeriod-sig: 100.0% [61.67σ]  
LongPeriod-sig: N/A  
ModelChiSquare2-sig: 51.1%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 0.00e+00  
RollingBand-fgt: 1.00 [62/62]  
GhostDiagnostic-chr: 73.53  
Centroid-sig: 11.7%  
Centroid-so: 0.346 arcsec [1.26σ]  
OotOffset-rm: 0.090 arcsec [0.55σ]  
KicOffset-rm: 0.161 arcsec [1.16σ]  
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 010019643-01, PDC Light Curves

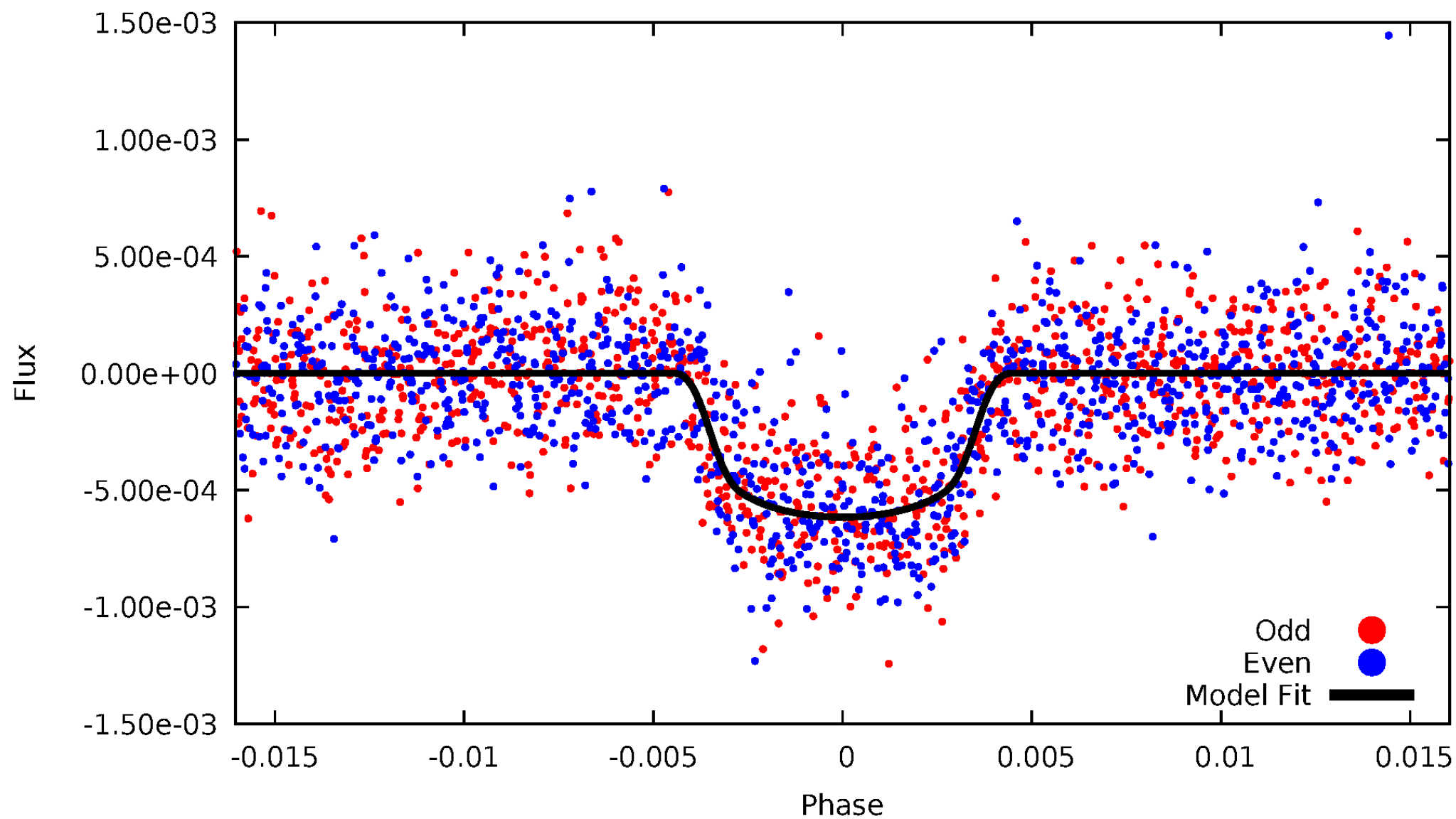


TCE 010019643-01



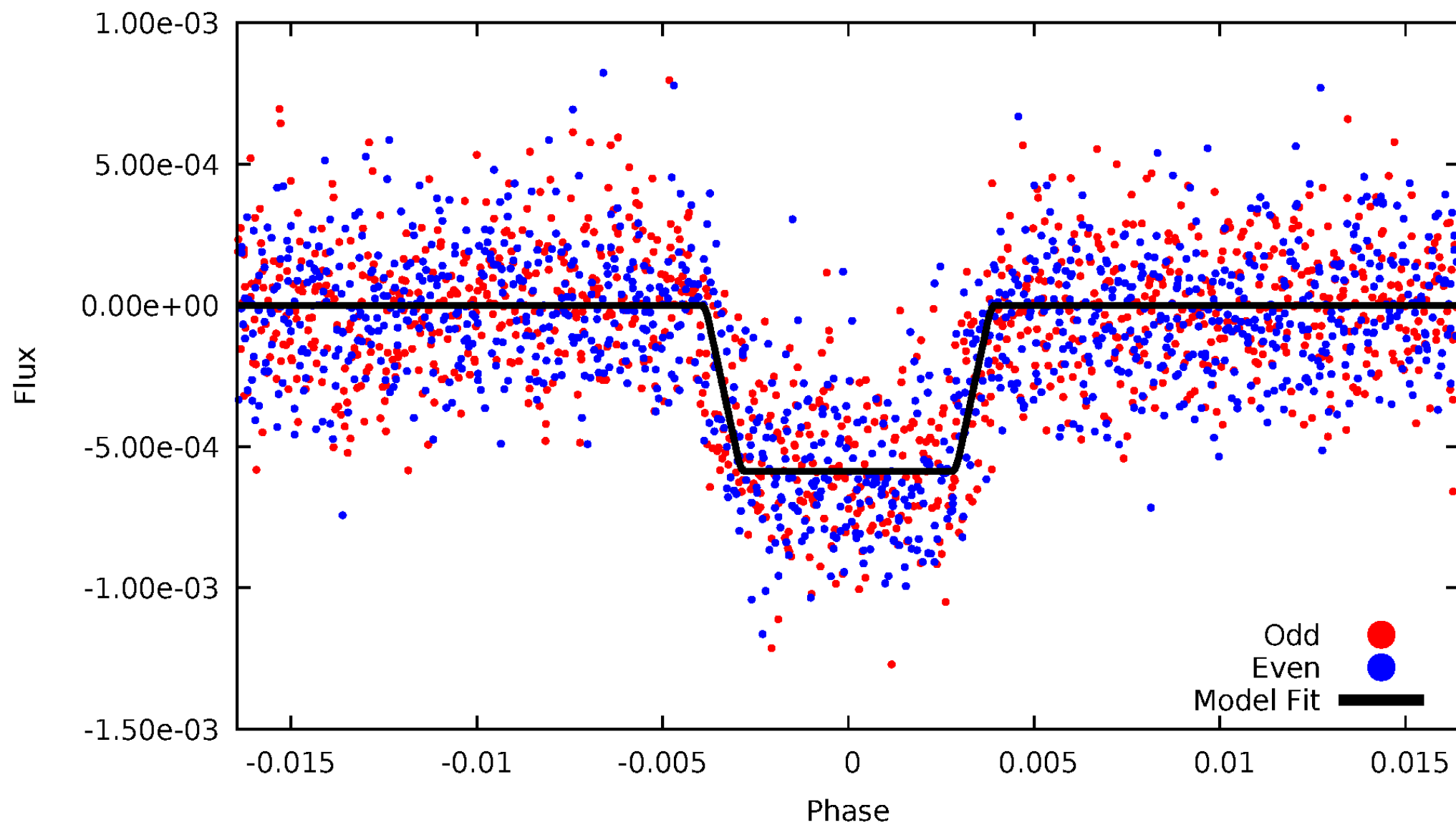
# DV Odd/Even

TCE 010019643-01



# ALT Odd/Even

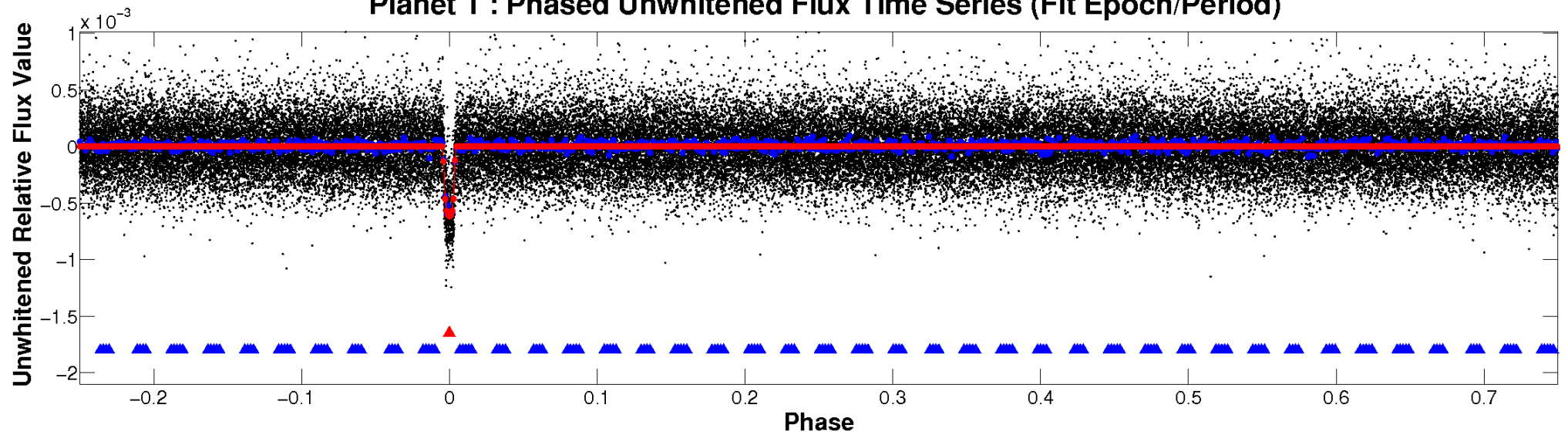
TCE 010019643-01



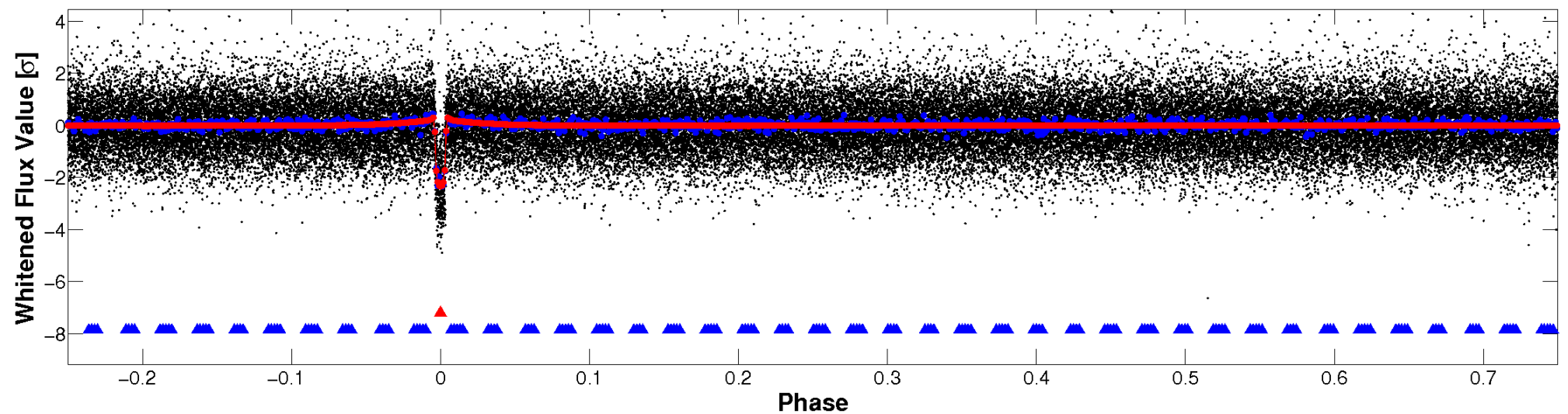


# Non-Whitened Vs. Whitened Light Curve

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

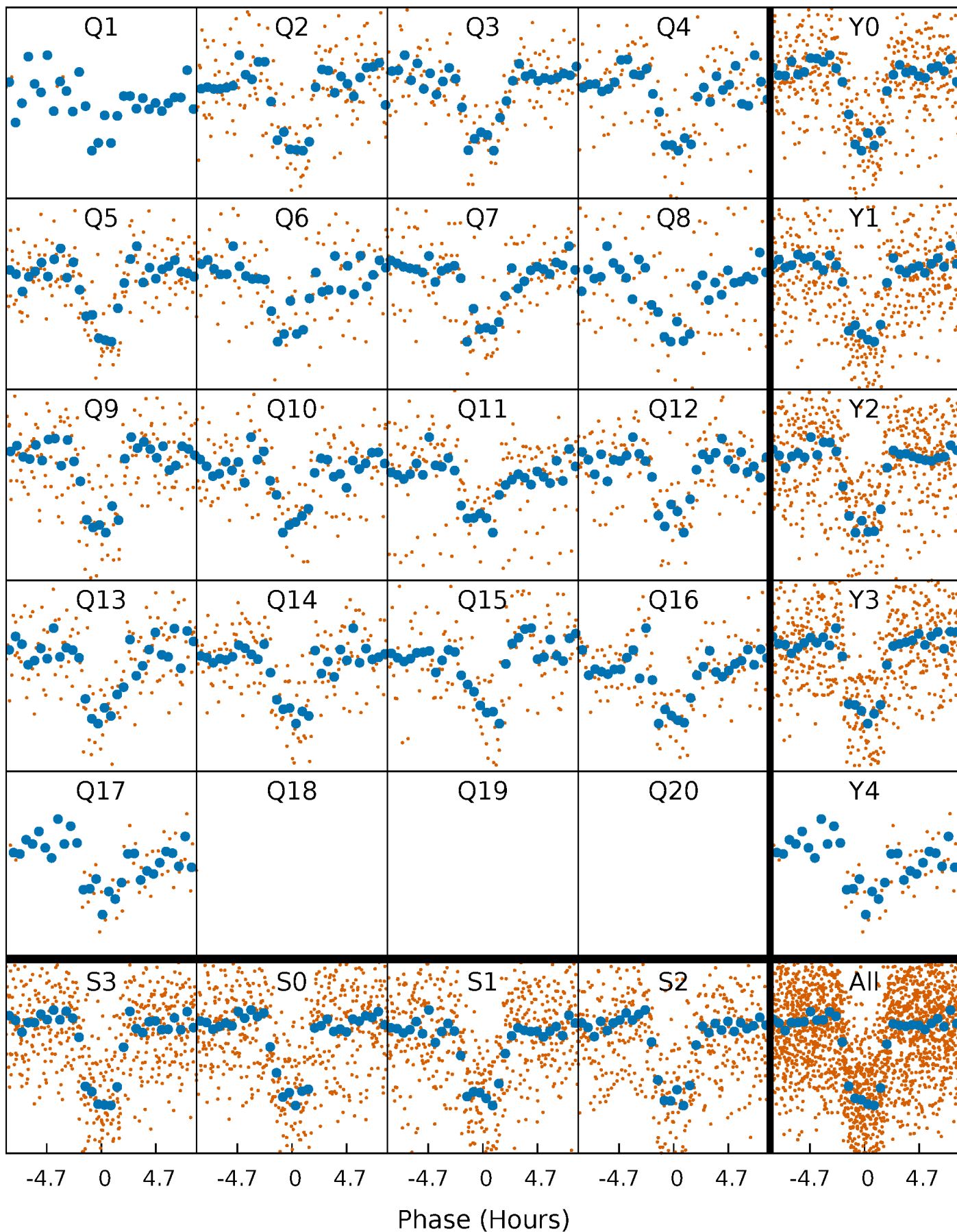


Planet 1 : Phased Whitened Flux Time Series (Fit Epoch/Period)



# PDC Quarter-Phased Transit Curves

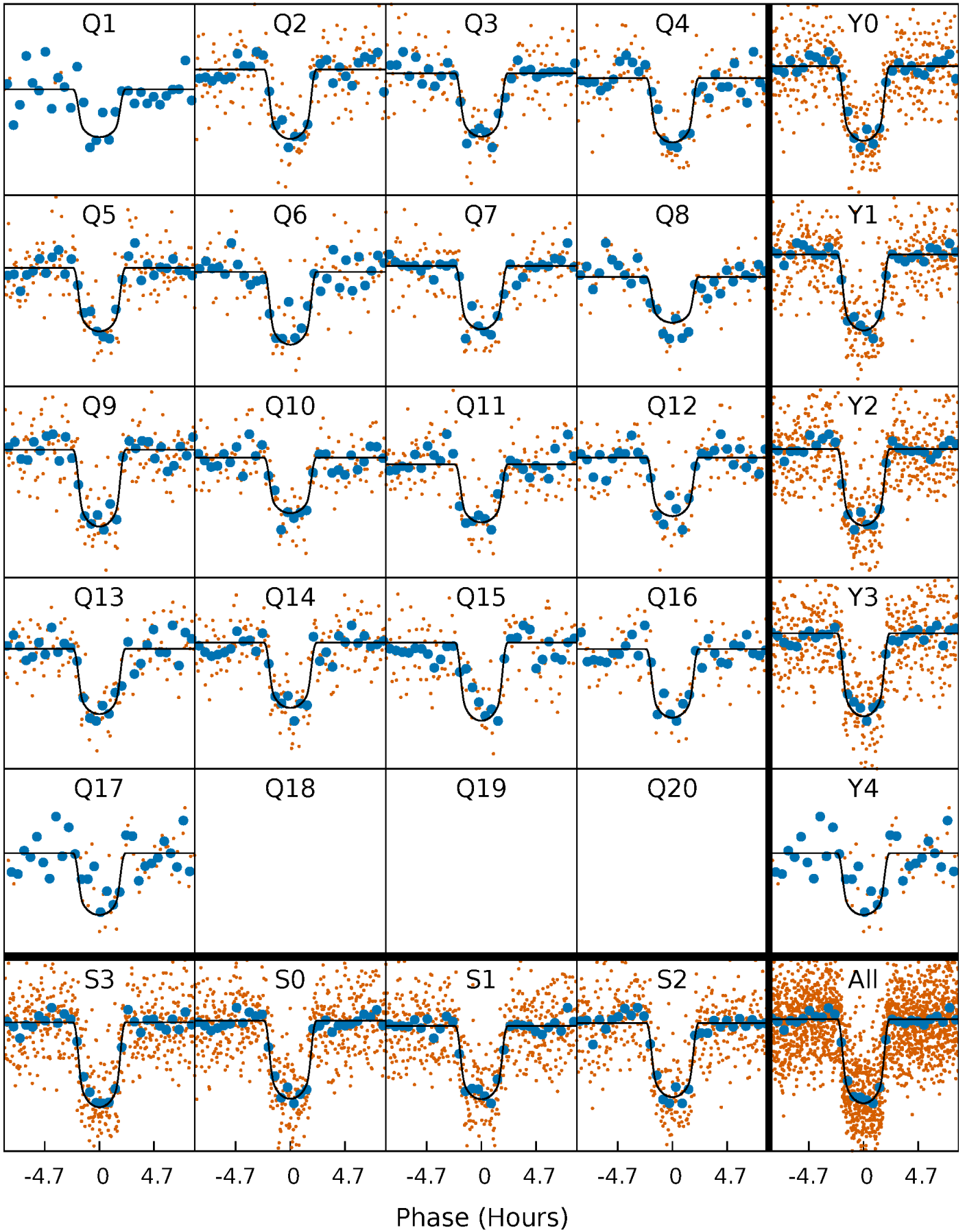
TCE 010019643-01 P= 21.347361 Days  $T_0=150.387624$  (BKJD)





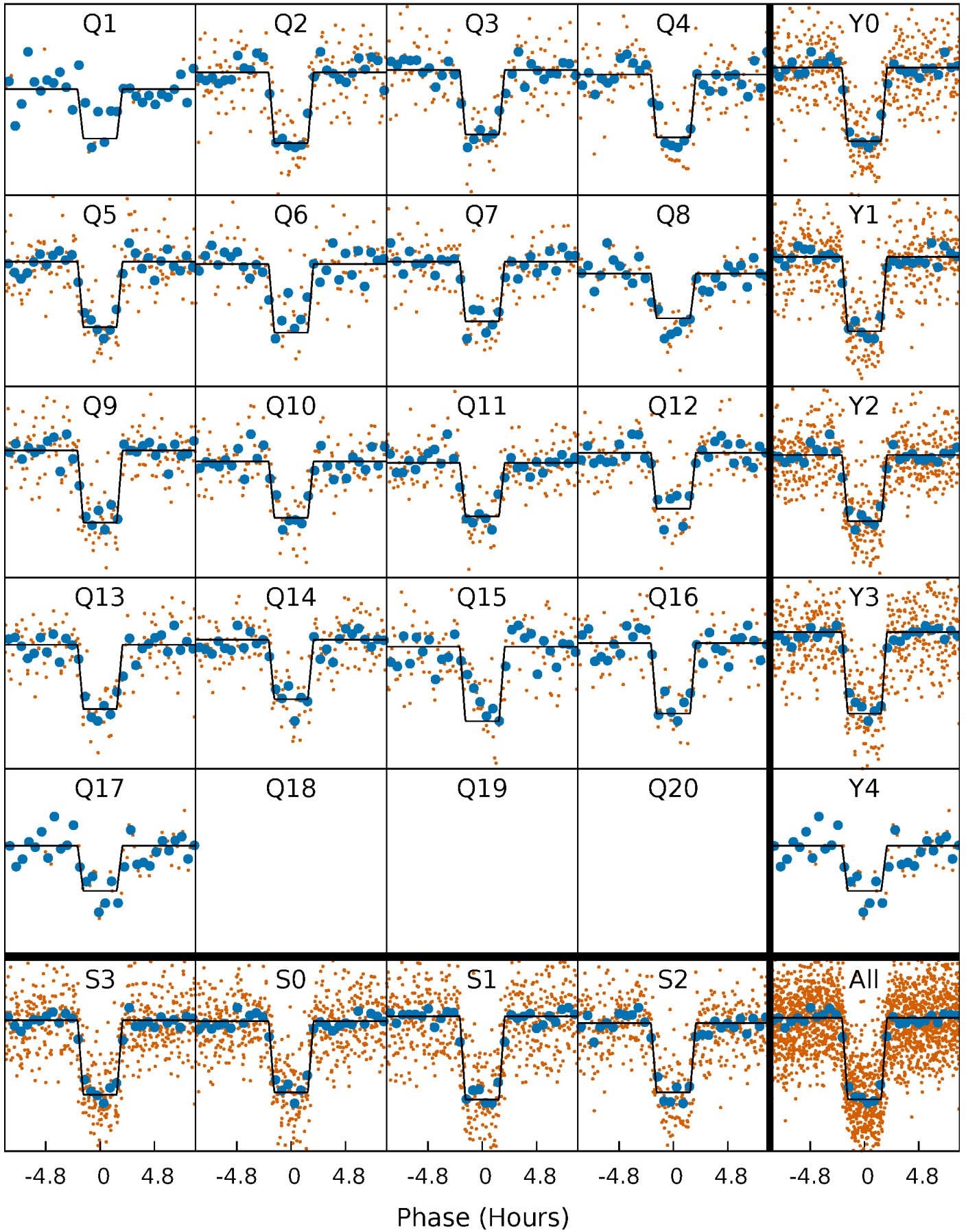
# DV Quarter-Phased Transit Curves

TCE 010019643-01 P= 21.347361 Days  $T_0=150.387624$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

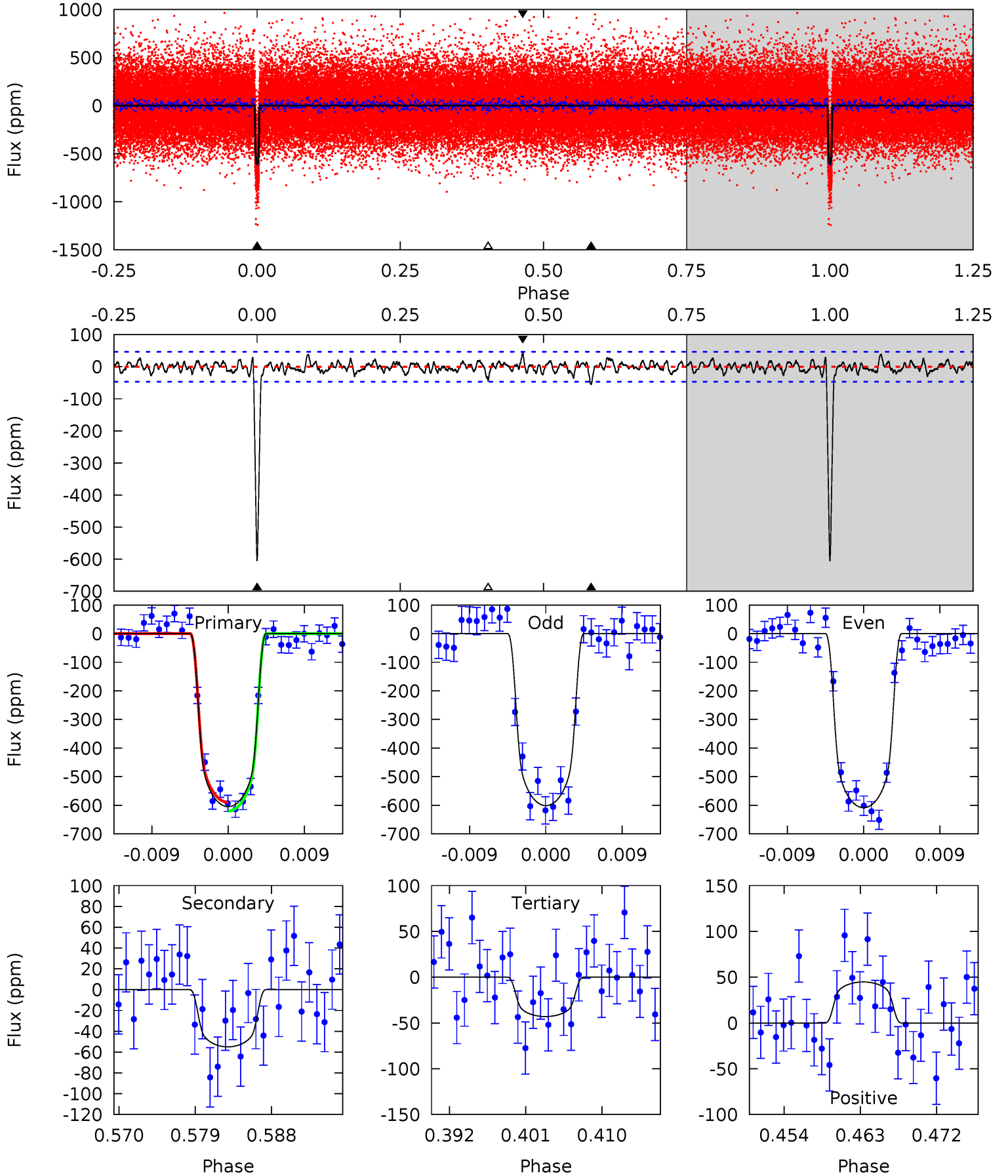
TCE 010019643-01   P= 21.347234 Days    $T_0=150.392598$  (BKJD)



# DV Model-Shift Uniqueness Test

010019643-01, P = 21.347361 Days, E = 129.040263 Days

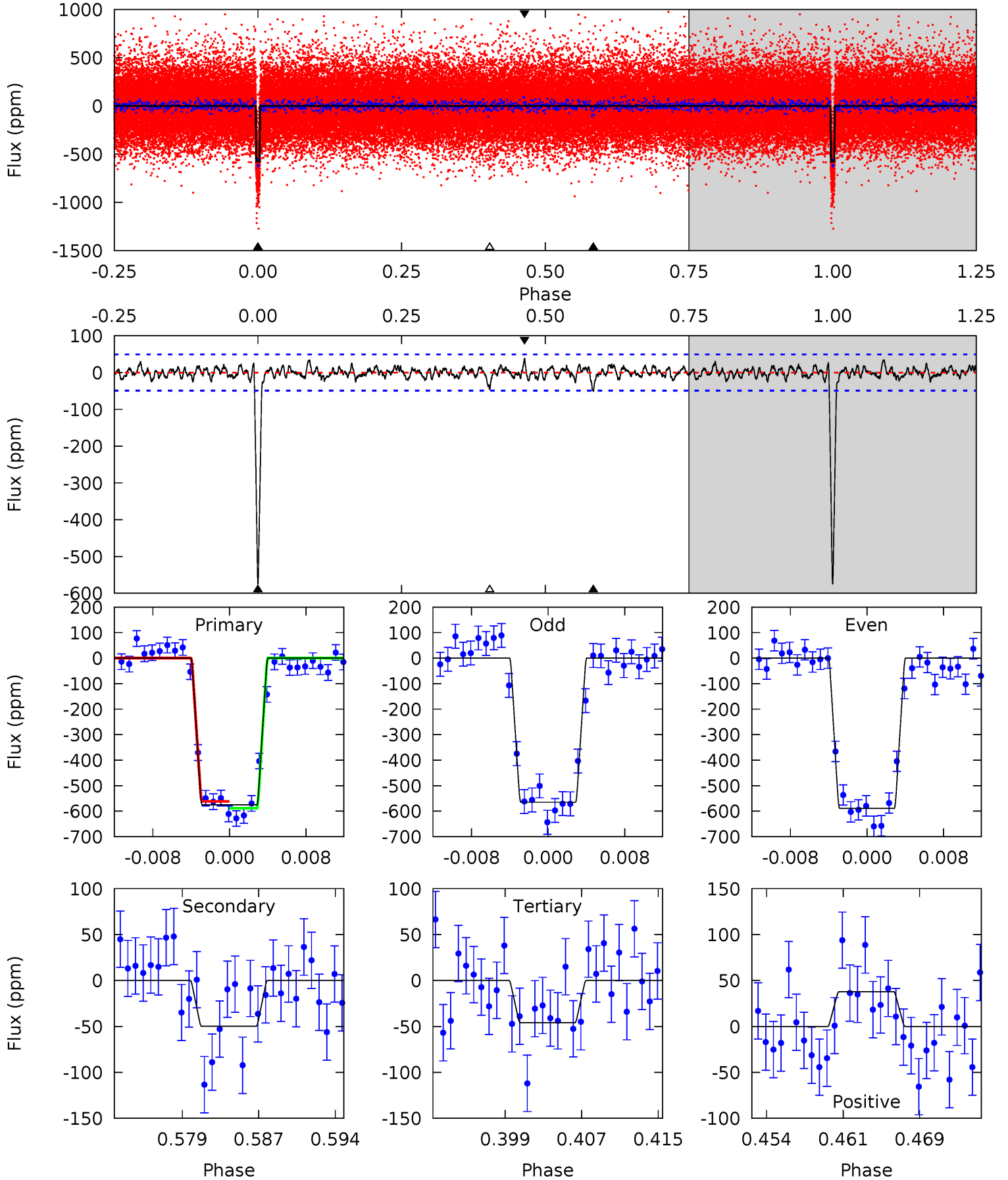
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
65.5	5.95	4.66	4.85	5.05	2.62	1.31	60.8	60.7	1.30	1.11	0.40	1.01	0.07	1.64



# Alt Model-Shift Uniqueness Test

010019643-01, P = 21.347234 Days, E = 129.045364 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
59.3	5.14	4.74	3.90	5.07	2.66	1.13	54.5	55.4	0.40	1.24	1.22	0.99	0.06	1.37



### Stellar Parameters For KIC 010019643

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R$ ( $R_{\odot}$ )	$M(M_{\odot})$	$p_{\star}$ ( $\text{g}\cdot\text{cm}^{-3}$ )
	$5395^{+80}_{-72}$	$4.324^{+0.154}_{-0.112}$	$0.160^{+0.150}_{-0.100}$	$1.071^{+0.180}_{-0.180}$	$0.882^{+0.065}_{-0.032}$	$1.012^{+0.703}_{-0.353}$
	+1%/-1%	+4%/-3%	+94%/-62%	+17%/-17%	+7%/-4%	+69%/-35%
Source	SPE90	SPE90	SPE90	DSEP		

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

### Secondary Eclipse Parameters for KIC 010019643-01 / KOI 0471.01

Detrend	Depth (ppm)	$R_p$ ( $R_{\oplus}$ )	$T_{max}$ (K)	$T_{obs}$ (K)	$A_{obs}$
DV	$-55 \pm 9$	$3.12^{+0.36}_{-0.34}$	$903^{+40}_{-44}$	$3353^{+122}_{-113}$	$65^{+21}_{-15}$
Alt.	$-50 \pm 10$	$2.81^{+0.36}_{-0.32}$	$902^{+45}_{-44}$	$3414^{+133}_{-135}$	$73^{+27}_{-20}$

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



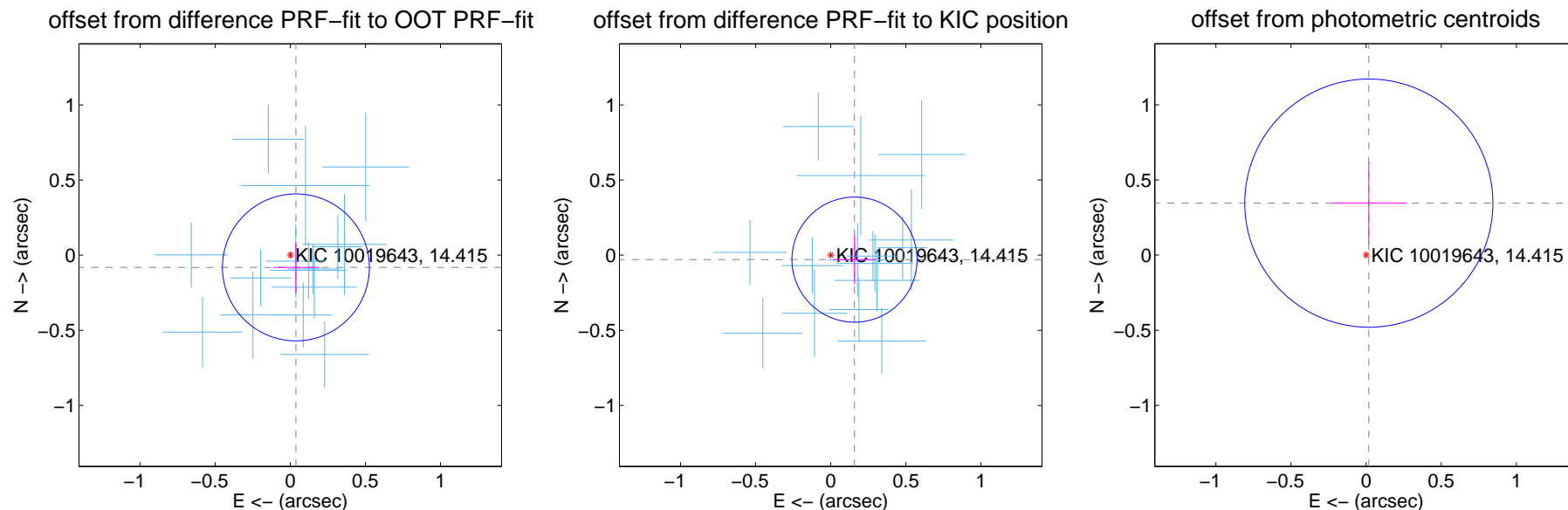
## DV Centroid Data

Supplemental centroid analysis for 010019643-01. Kepler magnitude: 14.41. Transit SNR 43.91

There are 17 quarters with good PRF difference image offsets

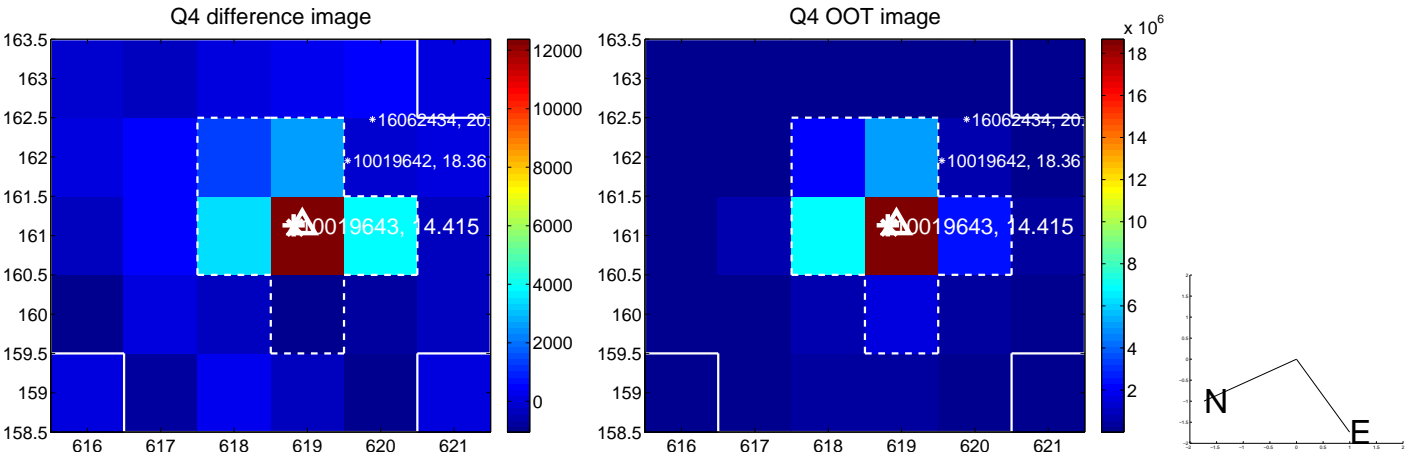
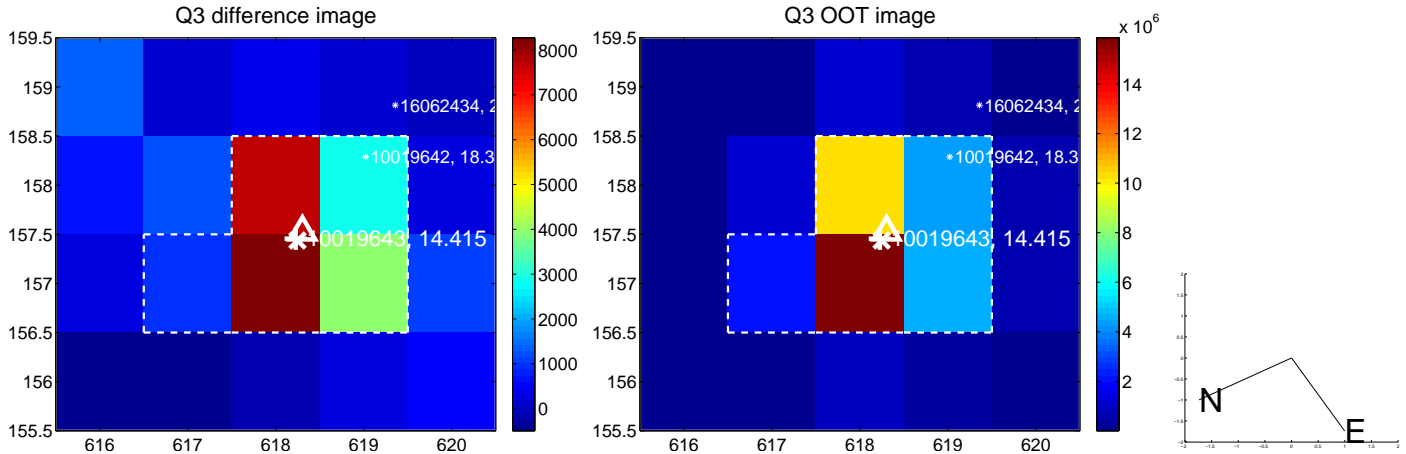
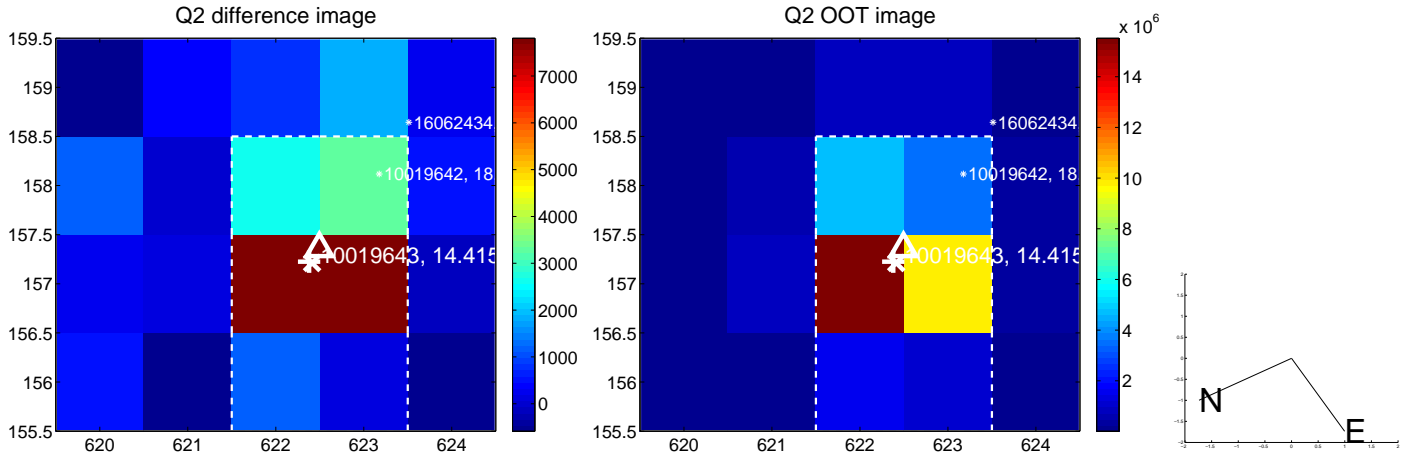
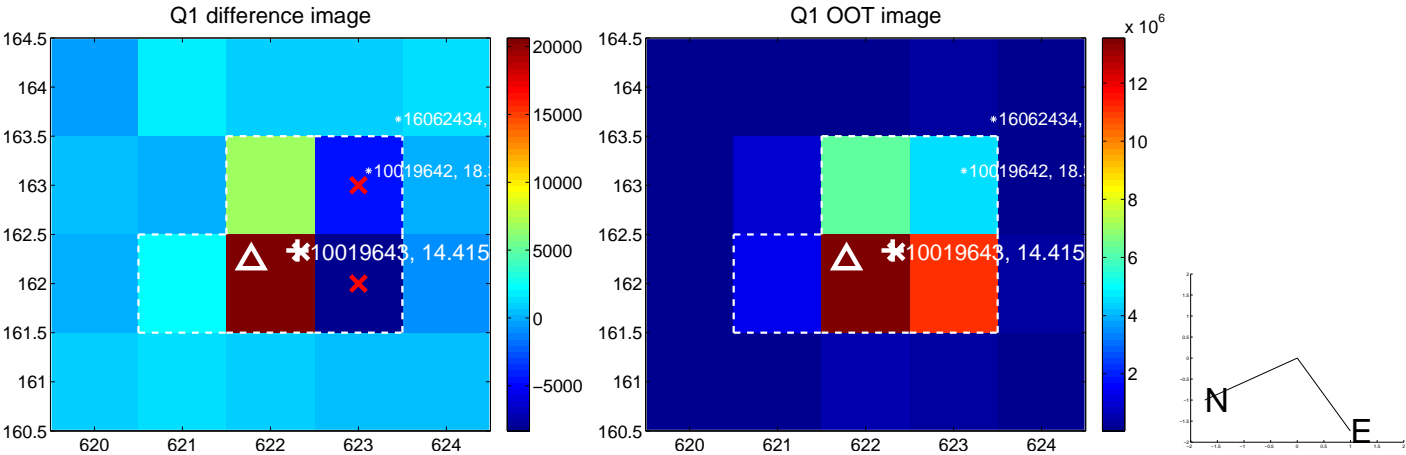
The direct PRF centroid is offset from the target star catalog position by about 0.13 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.090 \pm 0.163$	0.55	$-0.038 \pm 0.153$	$-0.082 \pm 0.168$
PRF-fit source offset from KIC position	$0.161 \pm 0.139$	1.16	$-0.158 \pm 0.142$	$-0.030 \pm 0.161$
photometric centroid source offset	$0.35 \pm 0.28$	1.26	$-0.02 \pm 0.25$	$0.35 \pm 0.28$

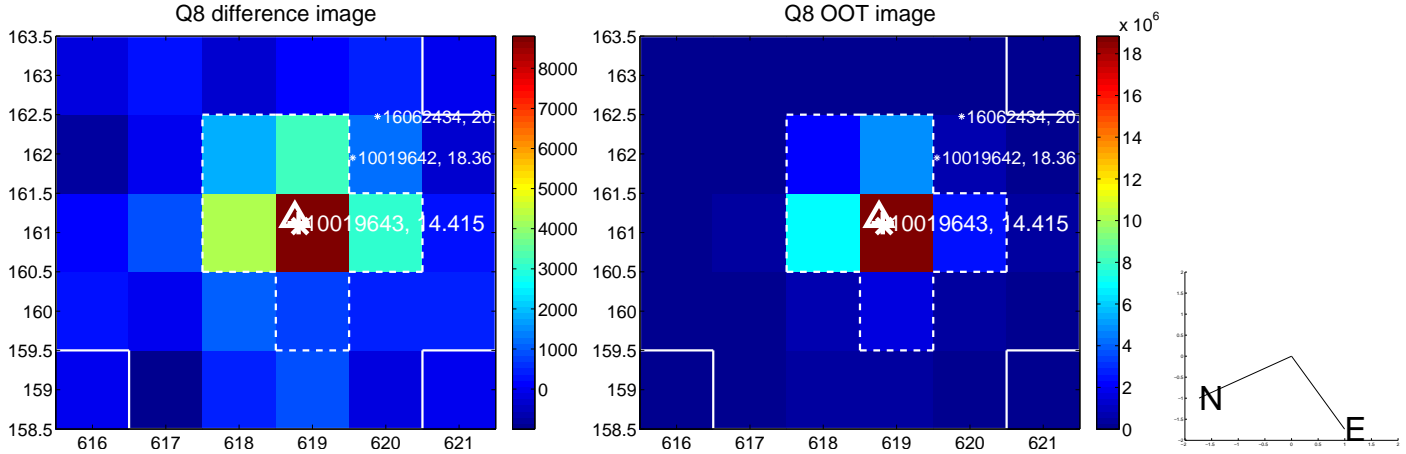
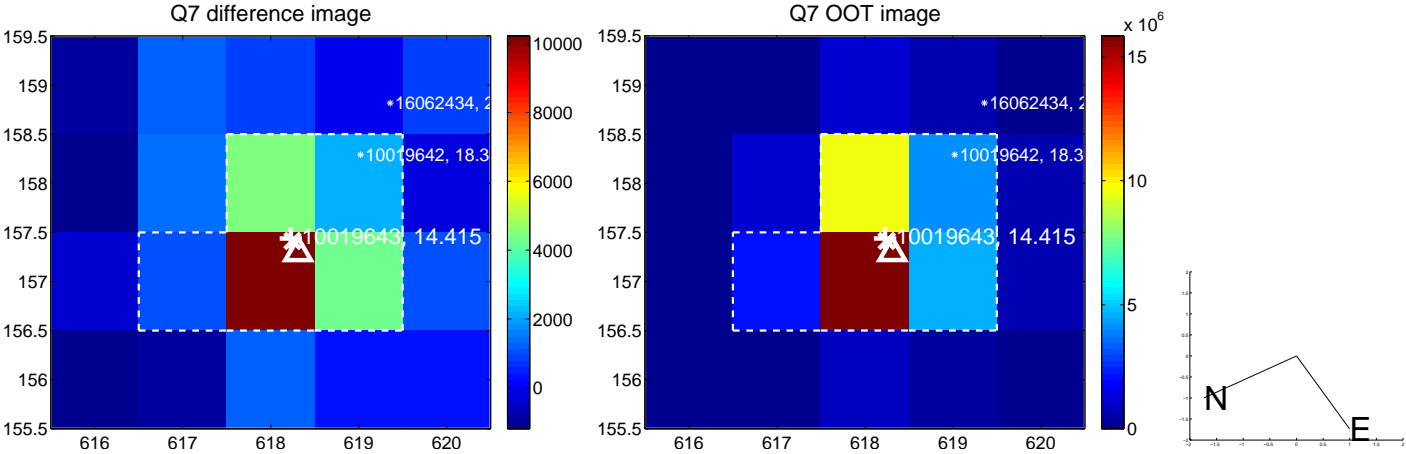
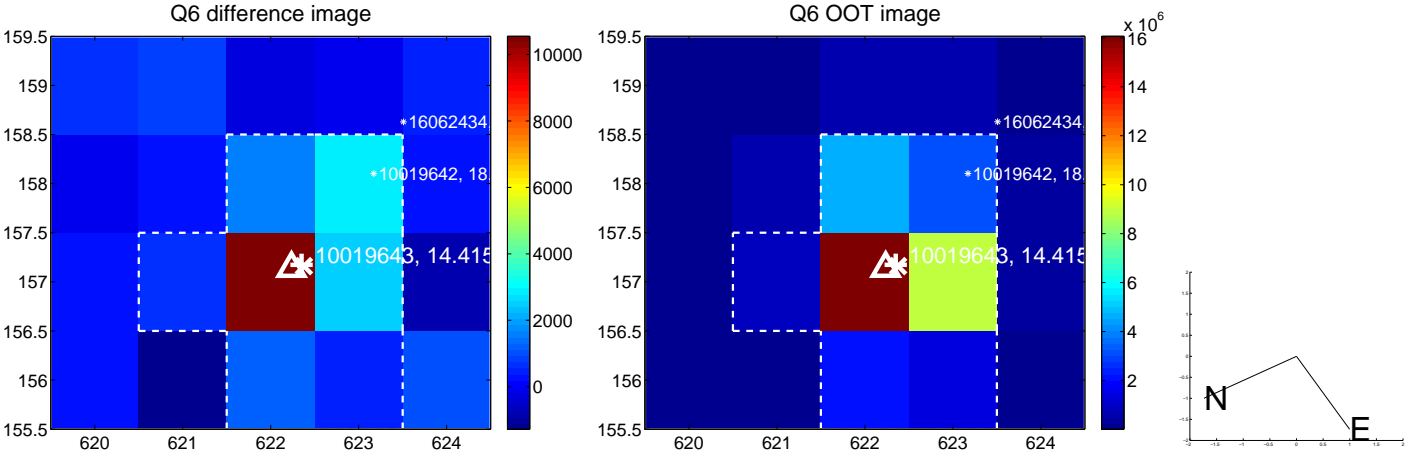
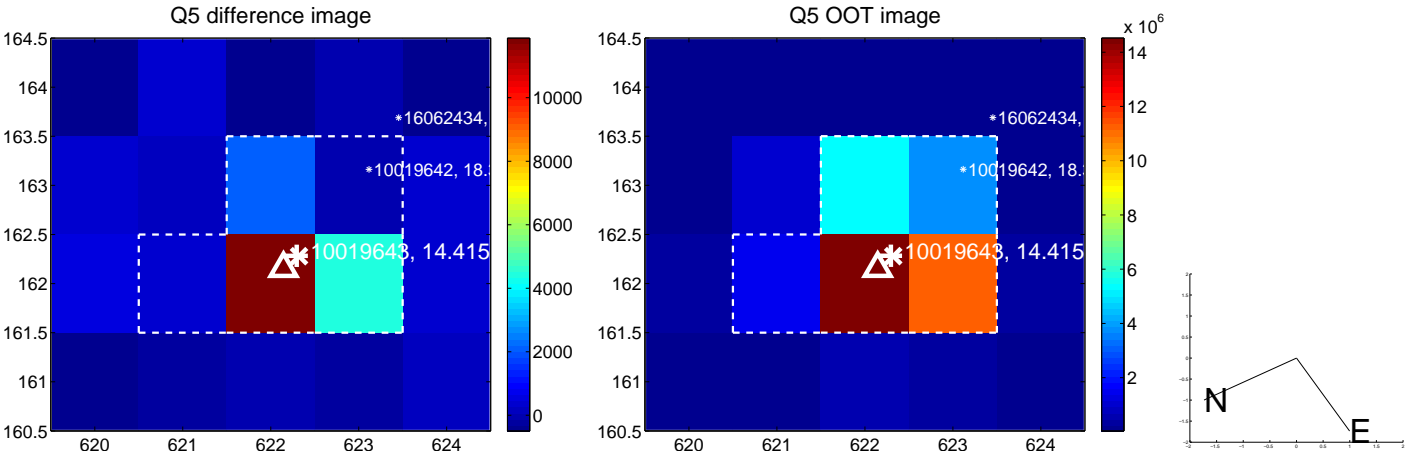


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses:** good quarterly centroid offsets; **Vermillion crosses:** bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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

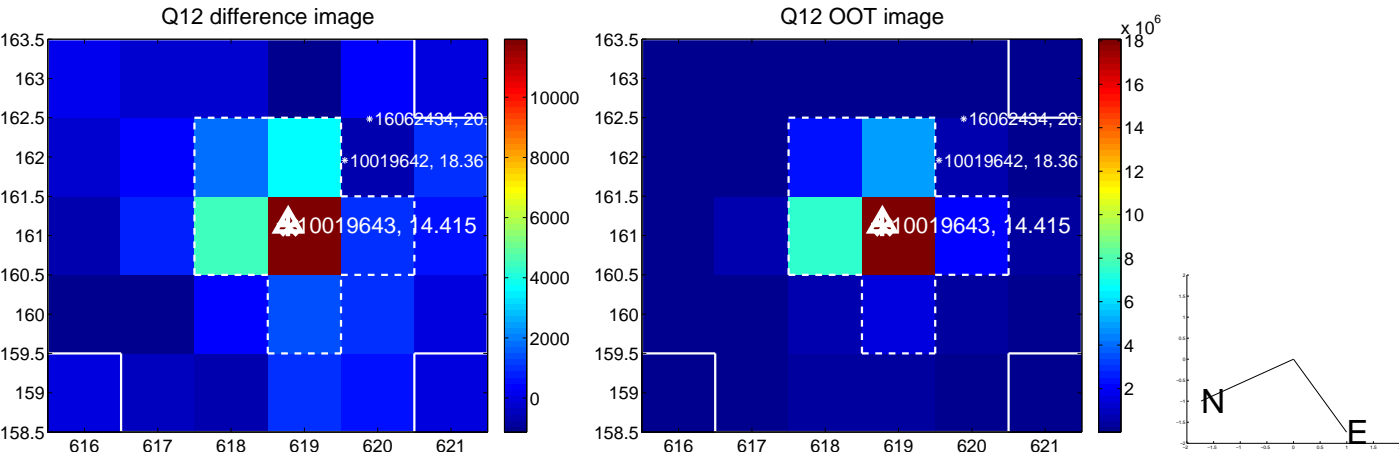
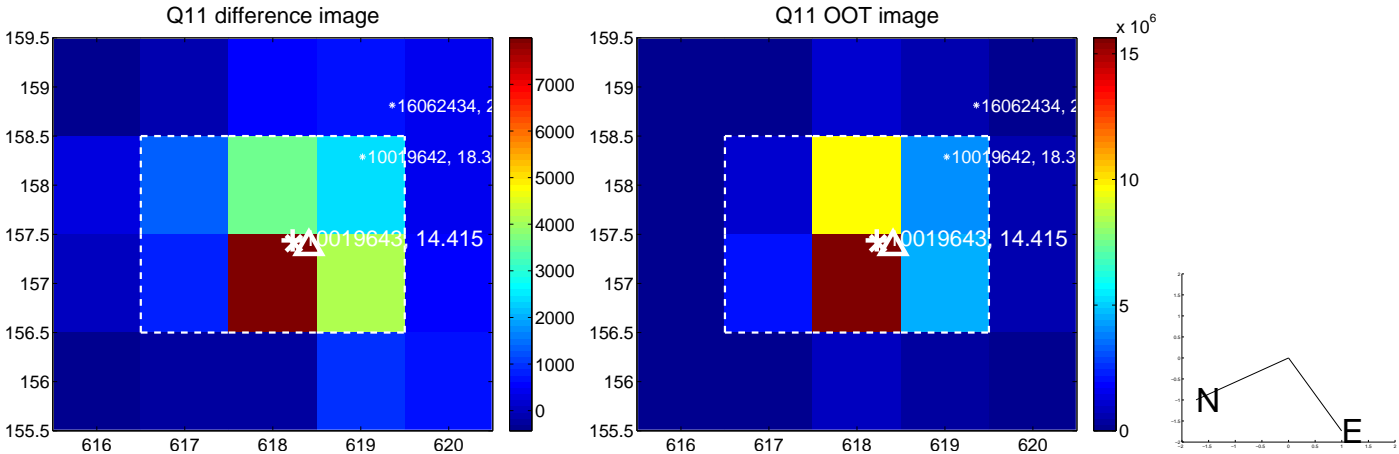
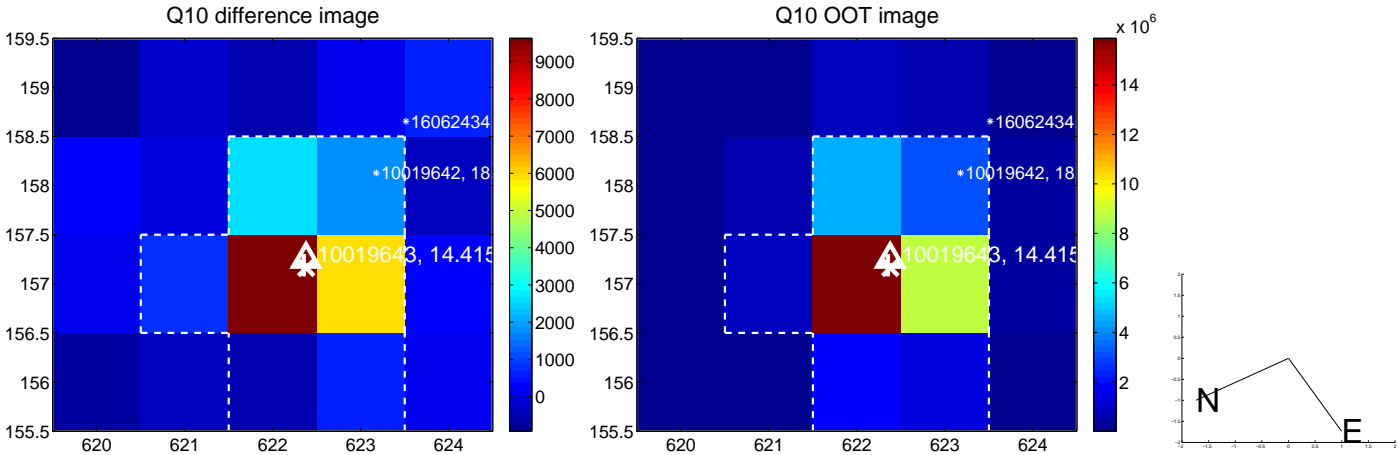
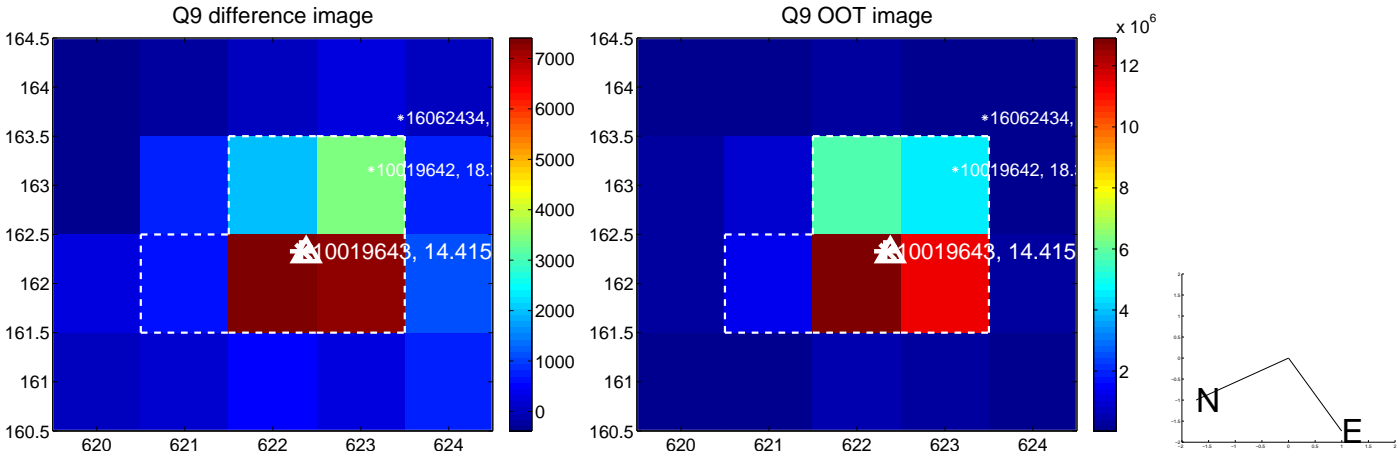
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



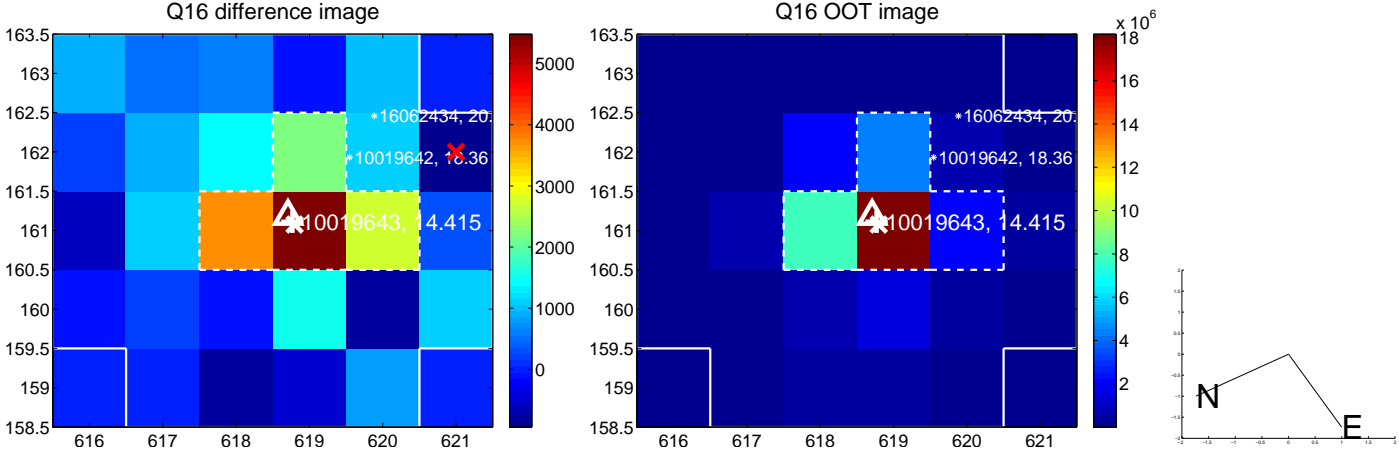
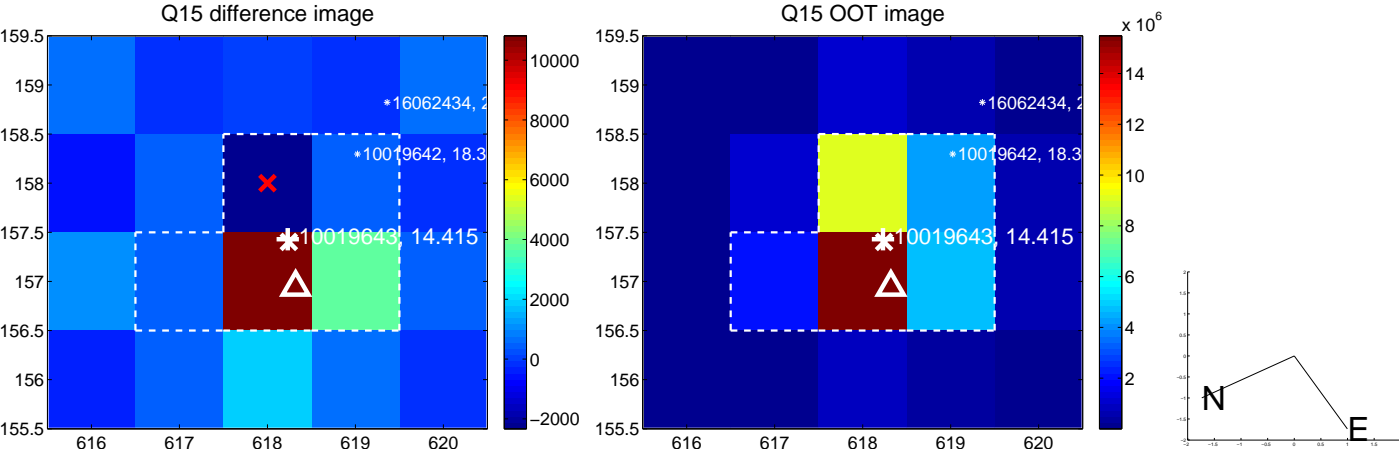
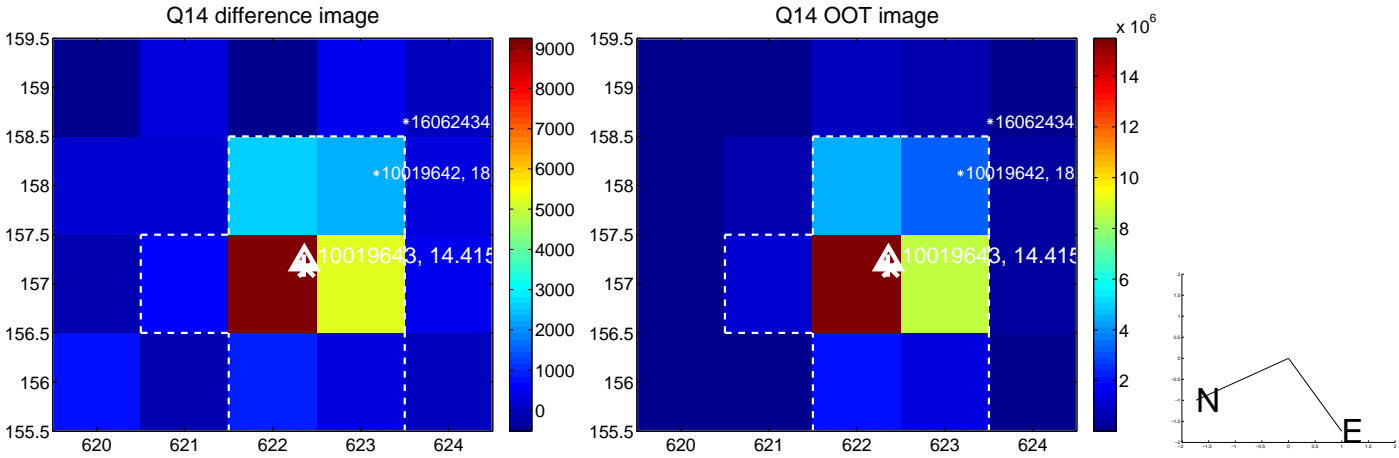
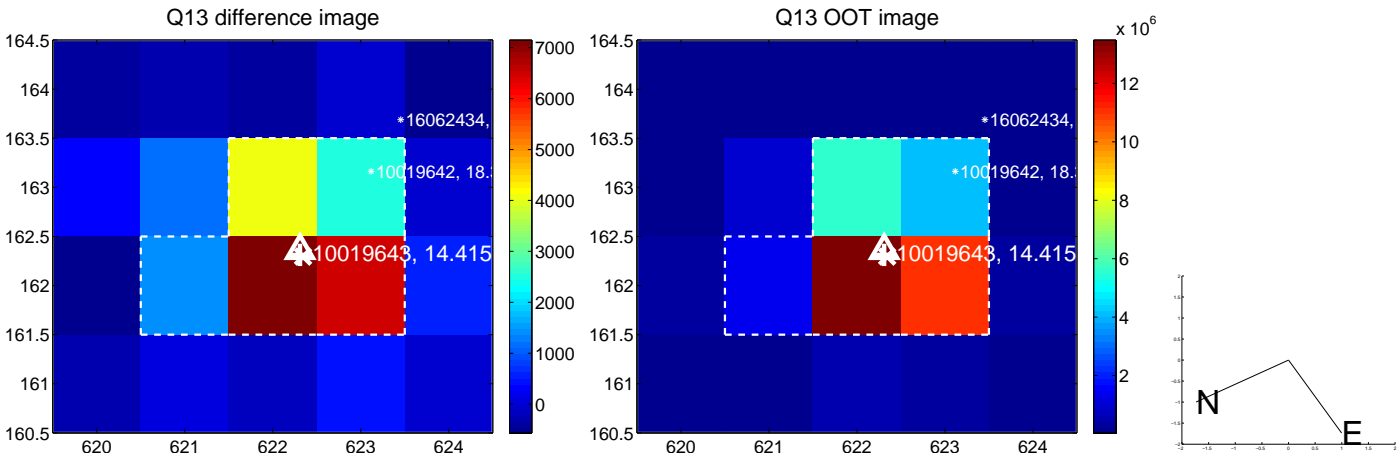
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

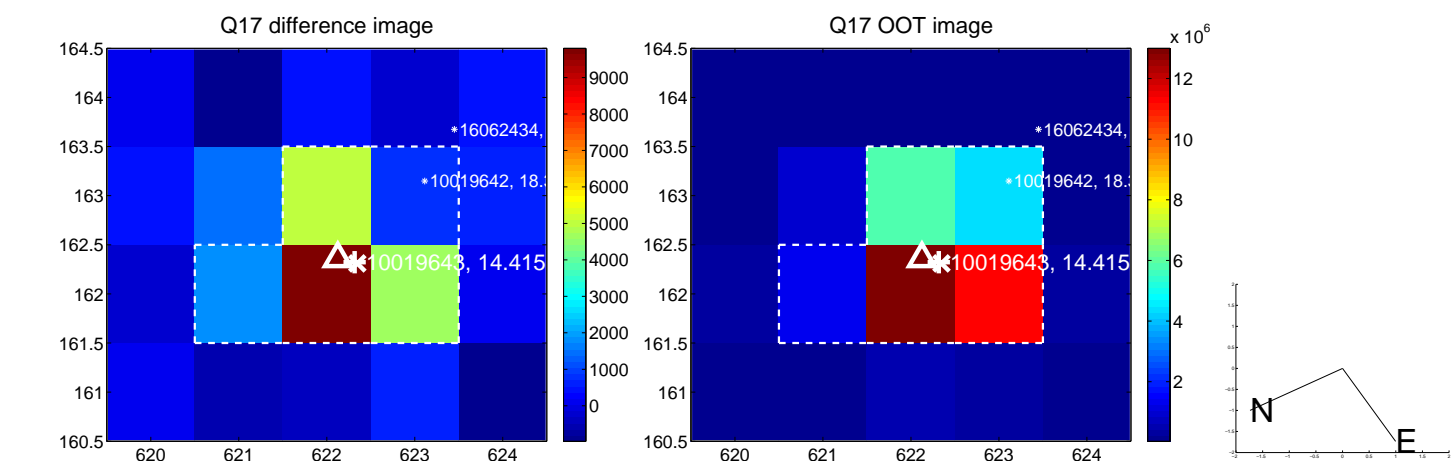


white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

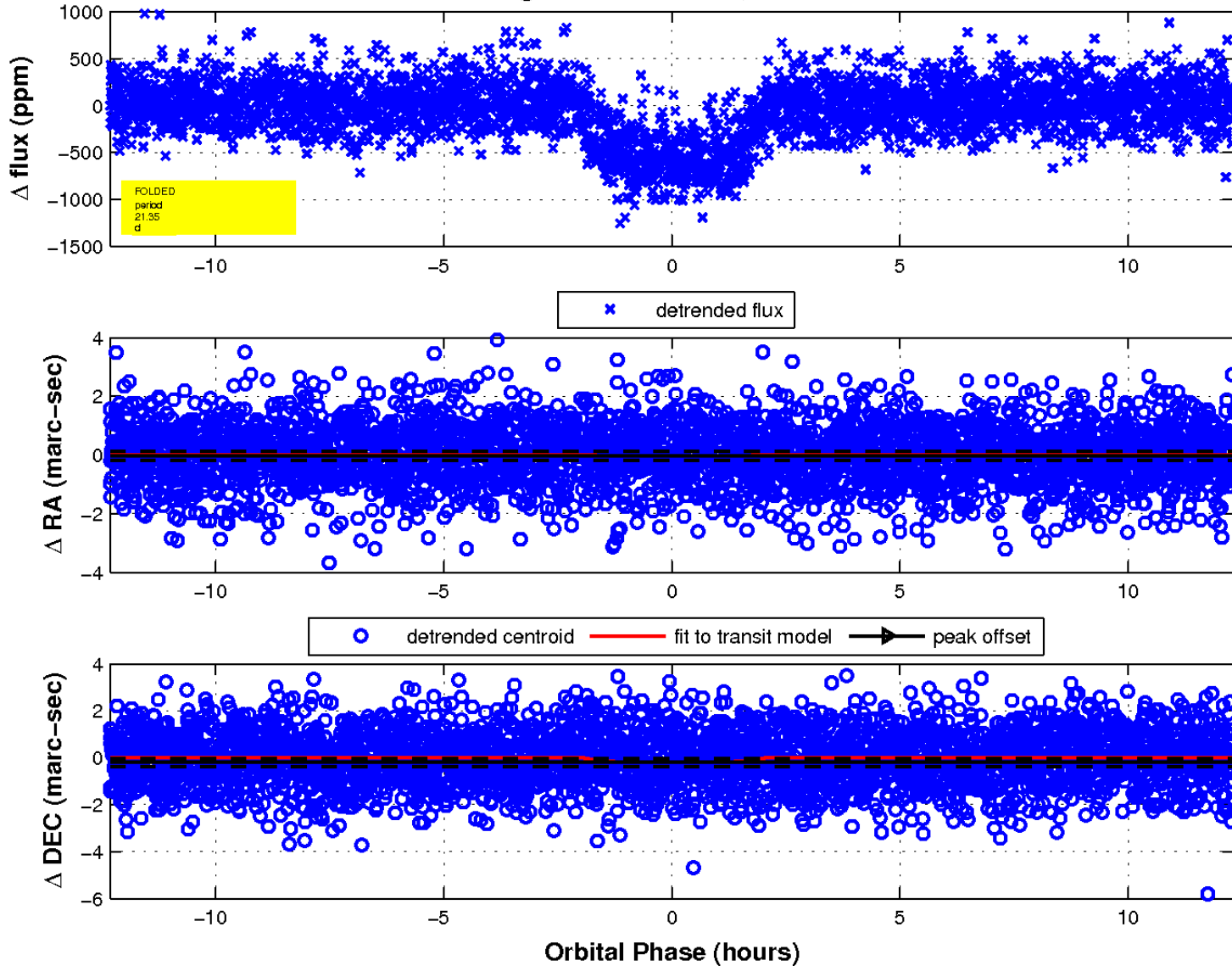




white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

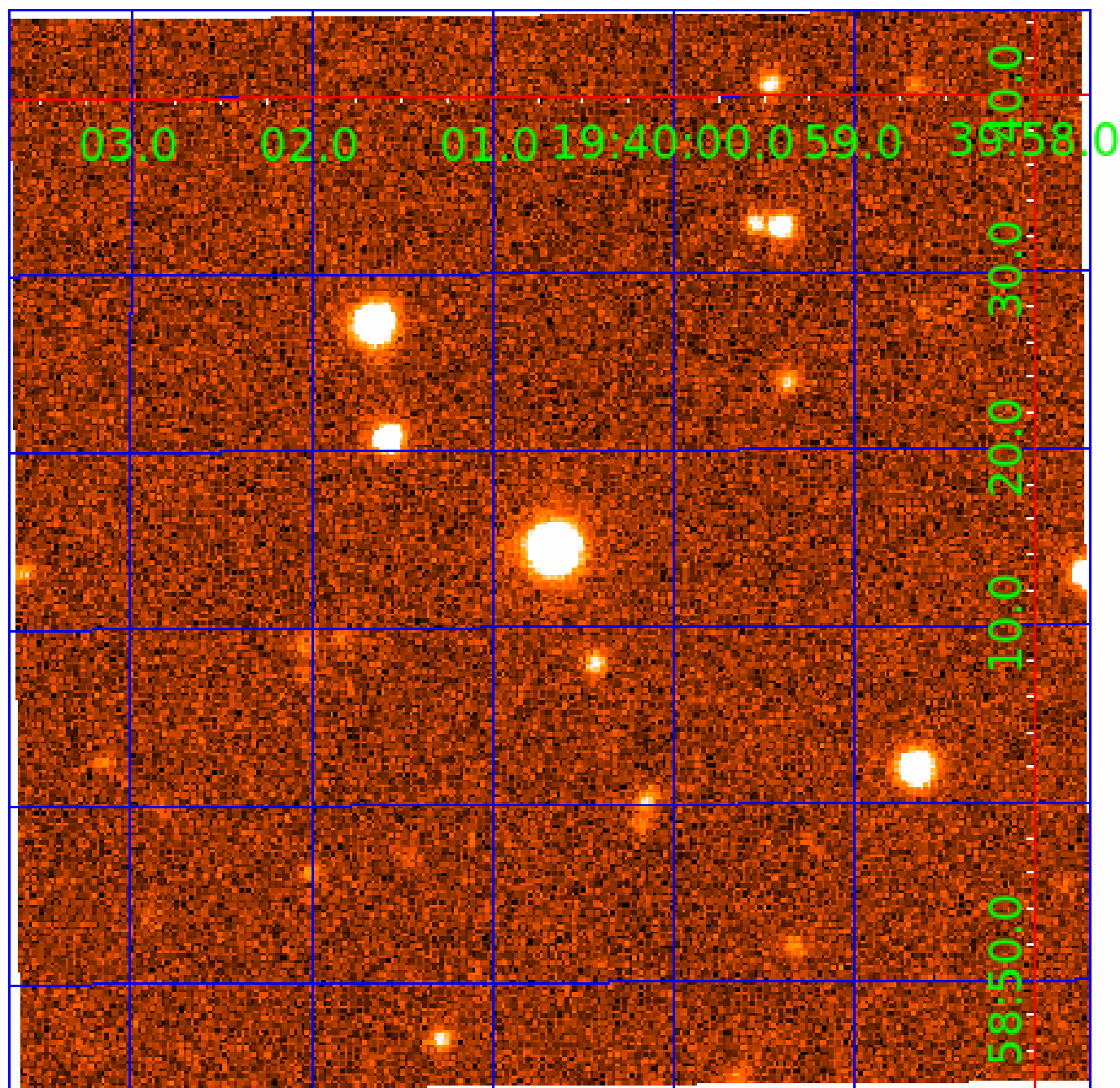


fluxWeightedCentroids, Planet 1 of 2



UKIRT Image

Declination



# KIC 010019643

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
010019643-01	OBS	0471.01	21.347361	150.387624	615.9	4.108	39.4	43.9	1.07	5395	3.14	41.71
010019643-02	OBS	0471.02	7.811039	132.300753	129.0	3.298	13.9	14.4	1.07	5395	1.42	159.38

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
010019643-01	OBS	PC	1.00	0	0	0	0	NO_COMMENT
010019643-02	OBS	PC	1.00	0	0	0	0	NO_COMMENT

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

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

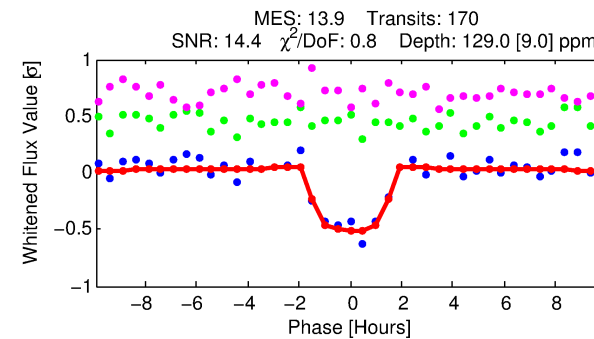
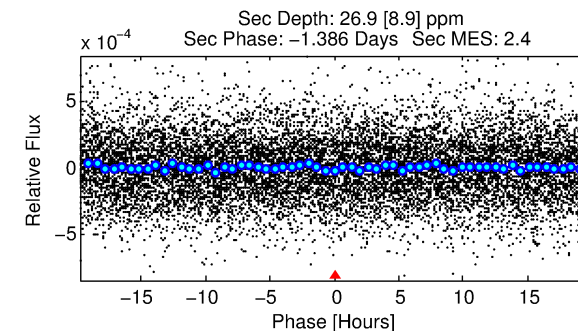
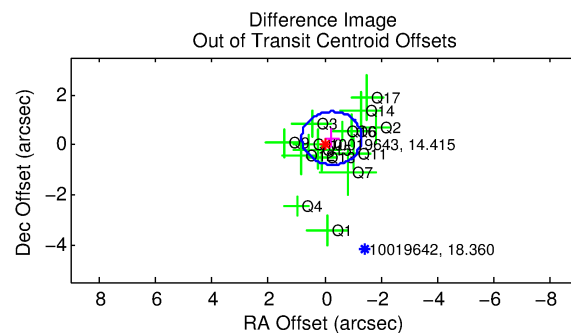
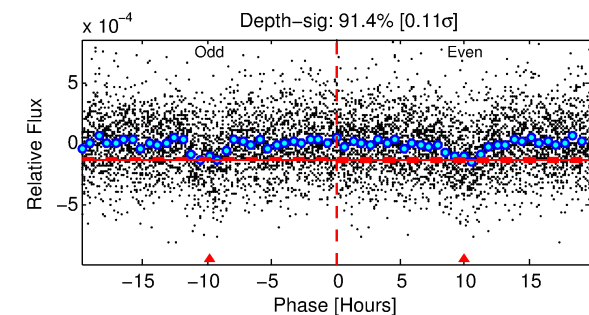
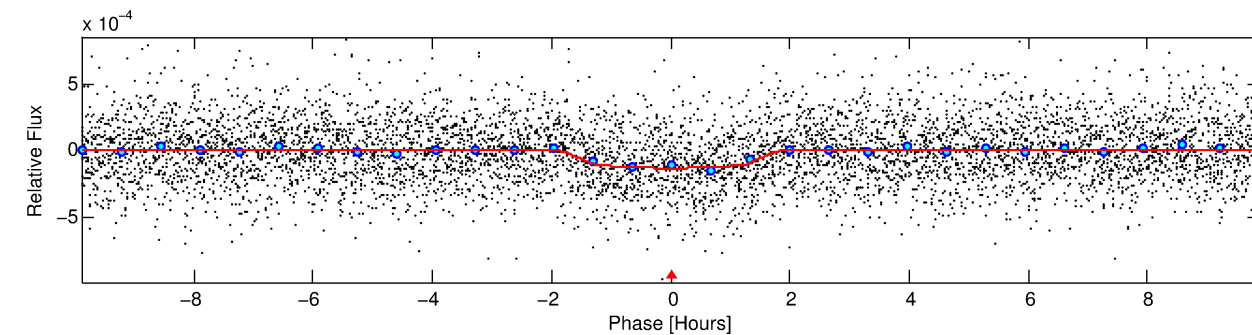
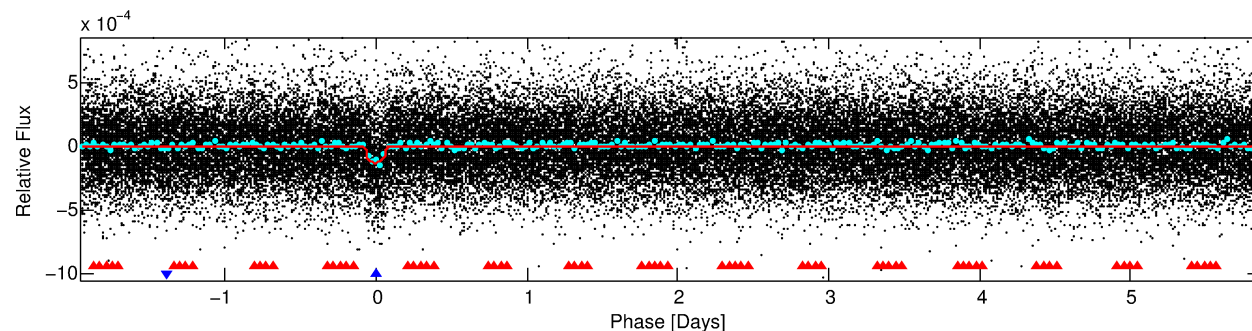
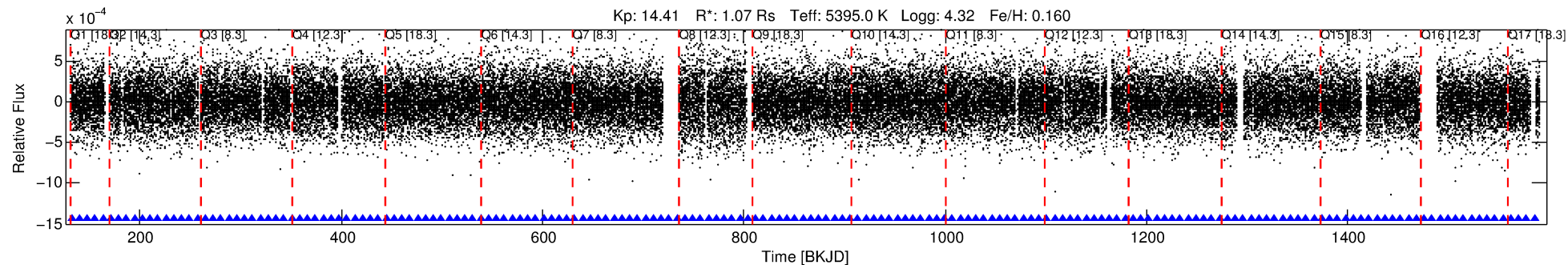
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 010019643-02

No Significant Match Found

# DV One-Page Summary

KIC: 10019643 Candidate: 2 of 2 Period: 7.811 d  
KOI: K00471.02 Name: Kepler-163b Corr: 0.977



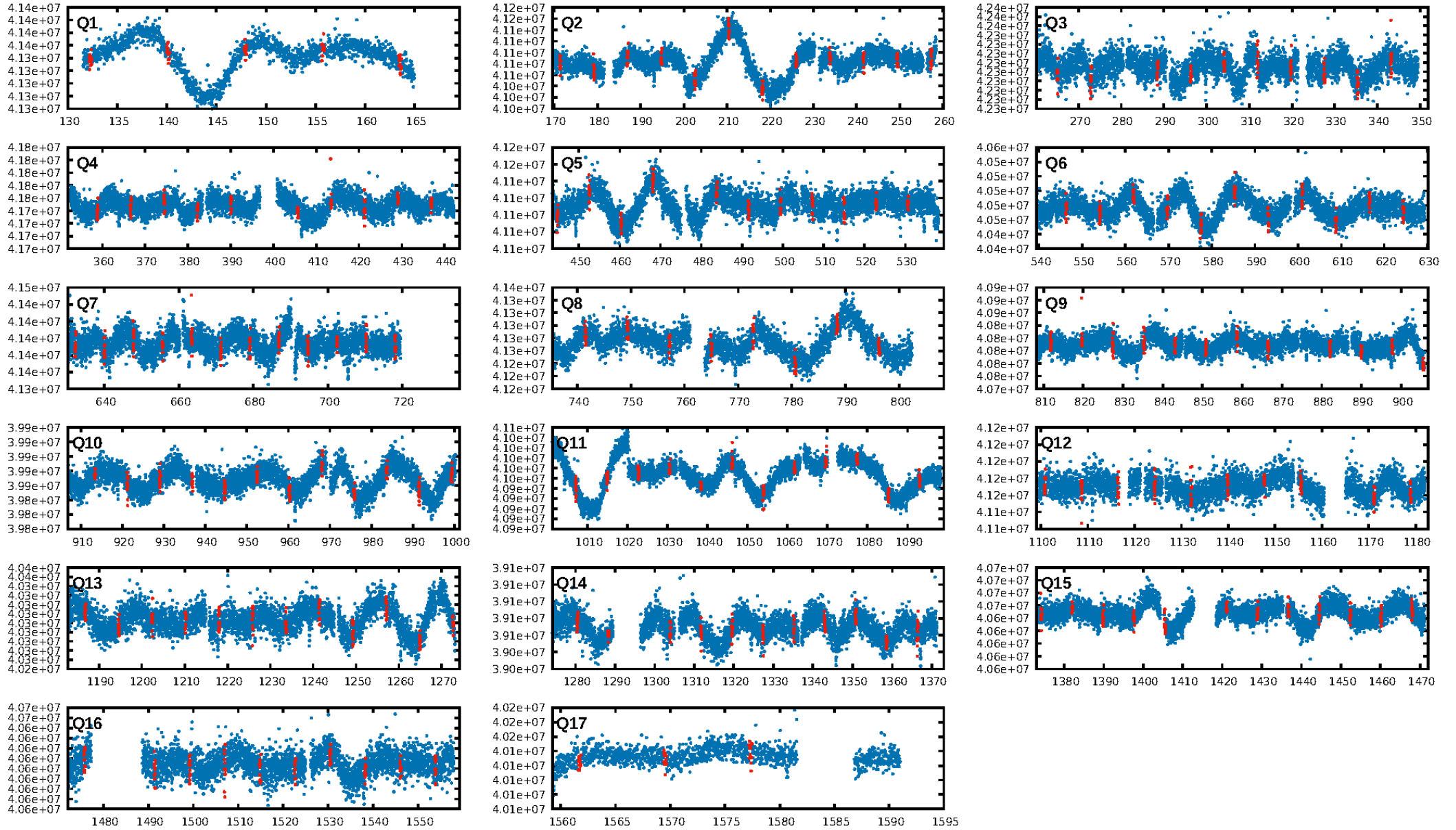
## DV Fit Results:

Period = 7.81104 [0.00004] d  
Epoch = 132.3008 [0.0043] BKJD  
Rp/R\* = 0.0121 [0.0069]  
a/R\* = 9.61 [22.47]  
b = 0.86 [0.71]  
Seff = 159.38 [42.75]  
Teq = 906 [61] K  
Rp = 1.42 [0.84] Re  
a = 0.0739 [0.0120] AU  
Ag = 40.33 [48.73] [0.81σ]  
Teffp = 3530 [1042] K [2.51σ]

## DV Diagnostic Results:

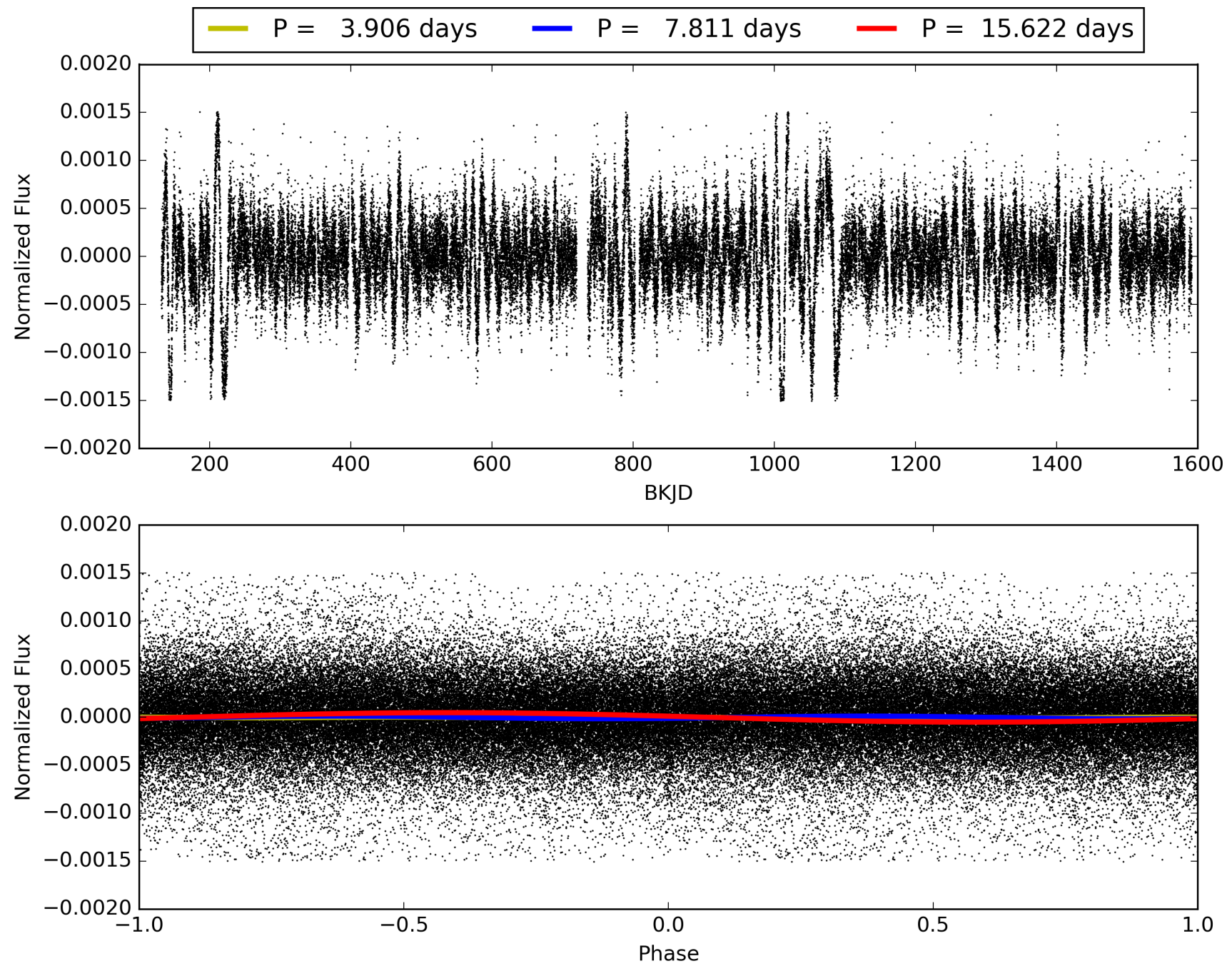
ShortPeriod-sig: N/A  
LongPeriod-sig: 100.0% [61.67σ]  
ModelChiSquare2-sig: 100.0%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 6.48e-43  
RollingBand-fgt: 1.00 [162/162]  
GhostDiagnostic-chr: 4.8  
Centroid-sig: 1.1%  
Centroid-so: 1.581 arcsec [1.87σ]  
OotOffset-rm: 0.363 arcsec [1.02σ]  
KicOffset-rm: 0.482 arcsec [1.45σ]  
OotOffset-st: 4/4/3/4 [15]  
KicOffset-st: 4/4/3/4 [15]  
DiffImageQuality-fgm: 0.93 [14/15]  
DiffImageOverlap-fno: 1.00 [17/17]

# TCE 010019643-02, PDC Light Curves



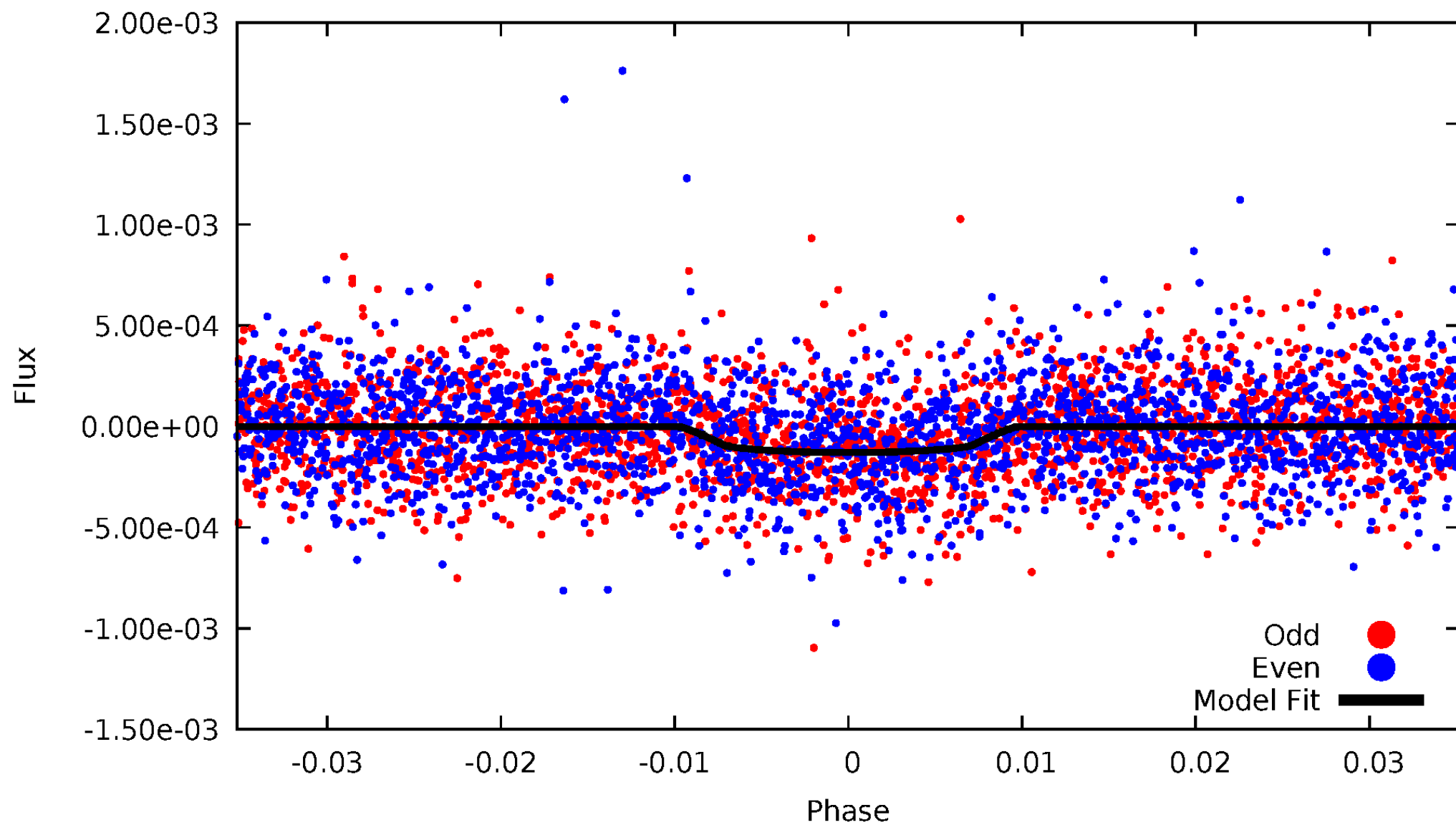


TCE 010019643-02



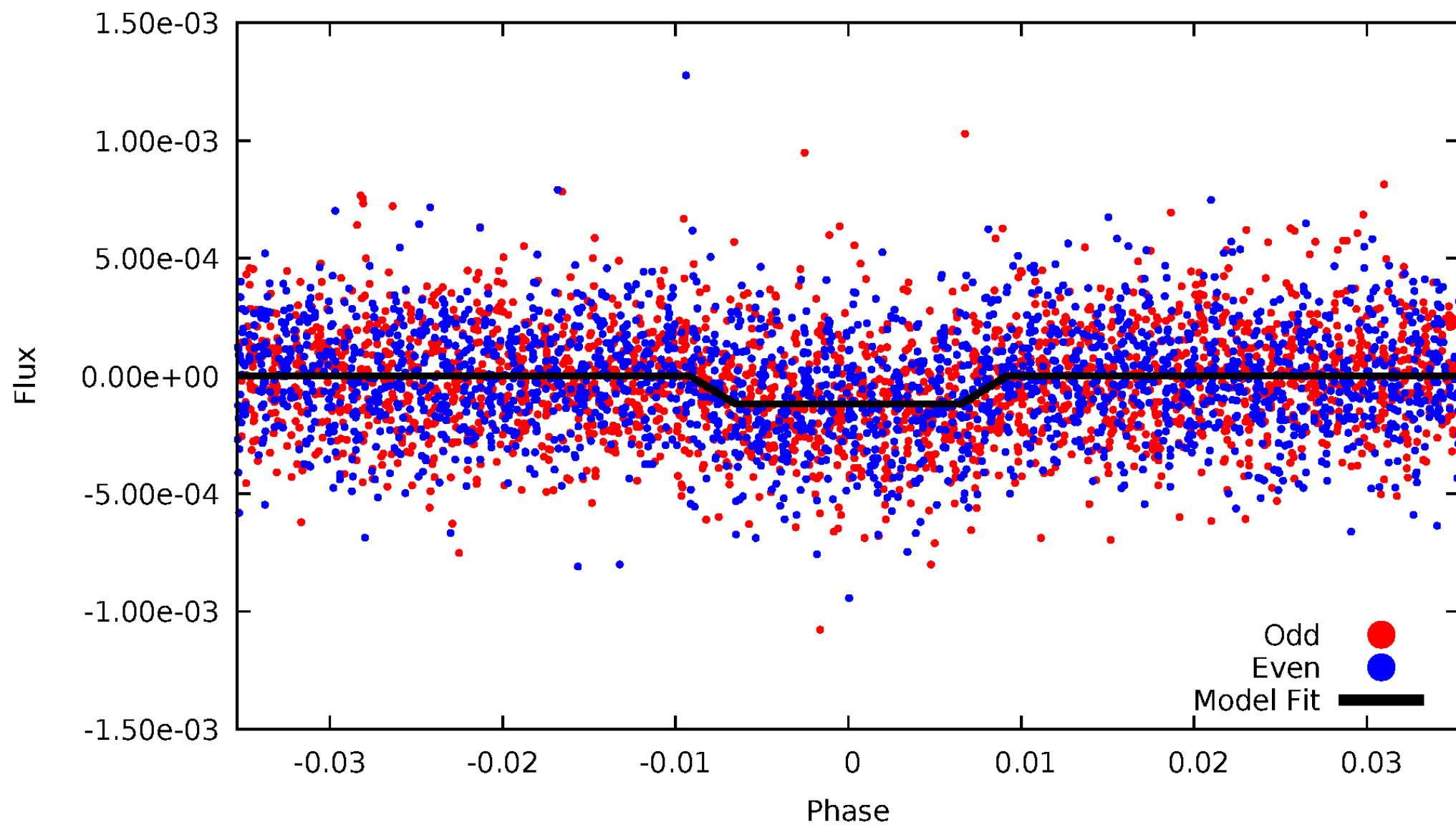
DV Odd/Even

TCE 010019643-02



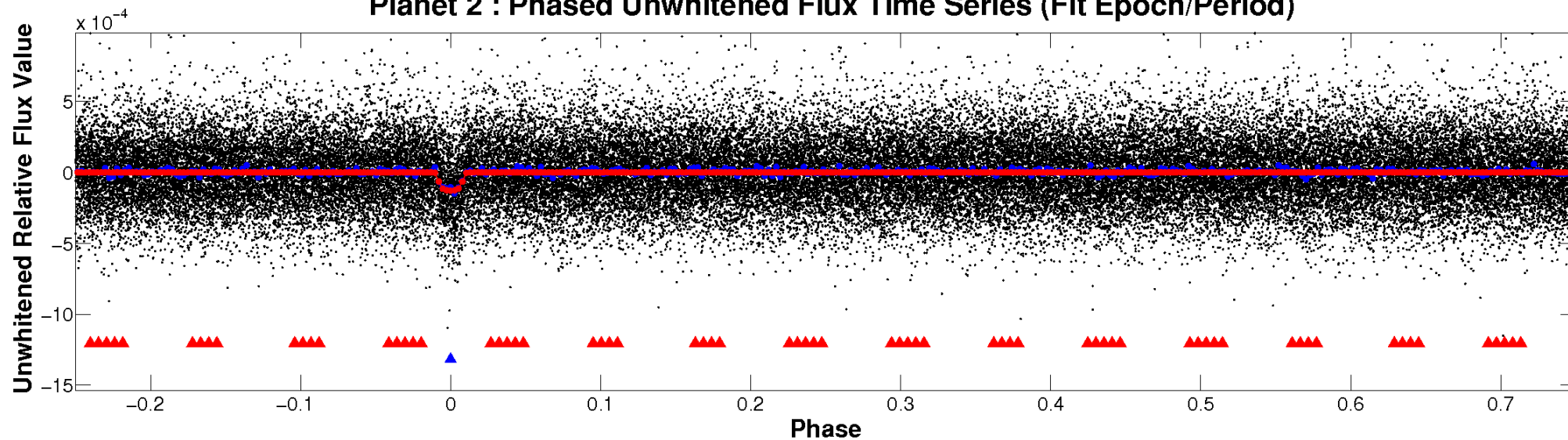
# ALT Odd/Even

TCE 010019643-02

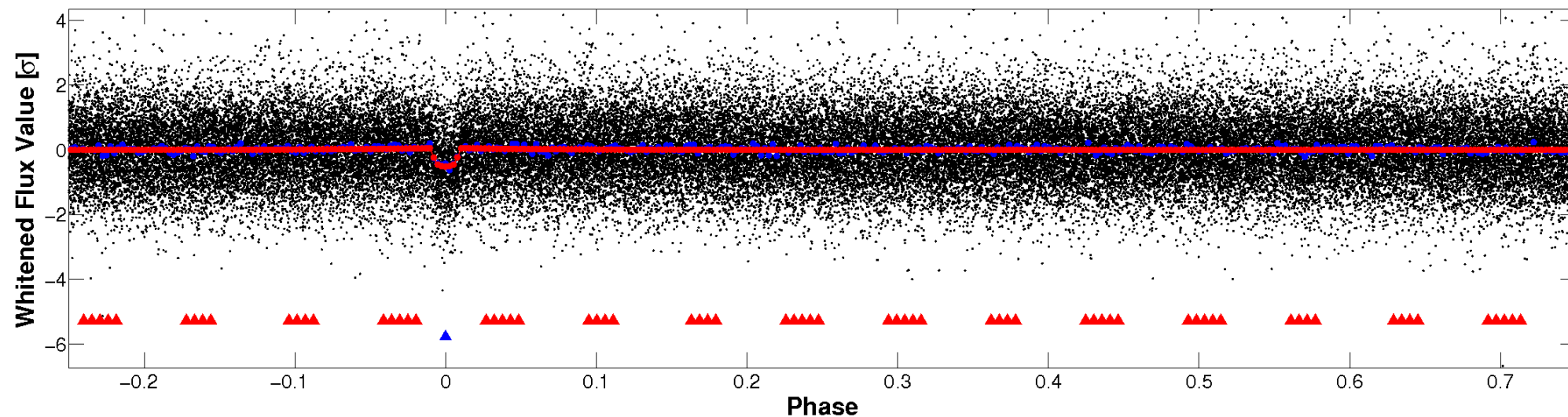


# Non-Whitened Vs. Whitened Light Curve

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

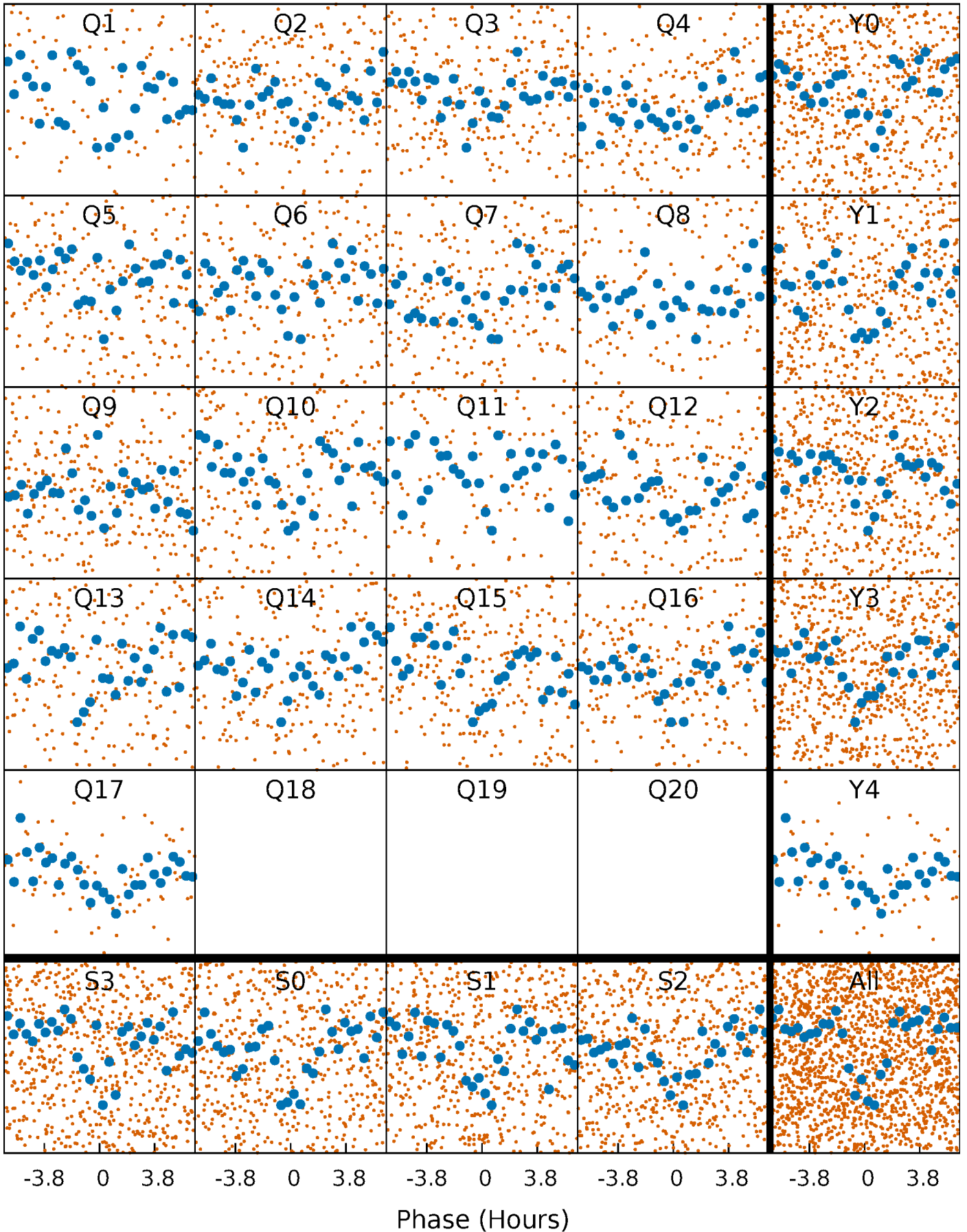


## Planet 2 : Phased Whitened Flux Time Series (Fit Epoch/Period)



# PDC Quarter-Phased Transit Curves

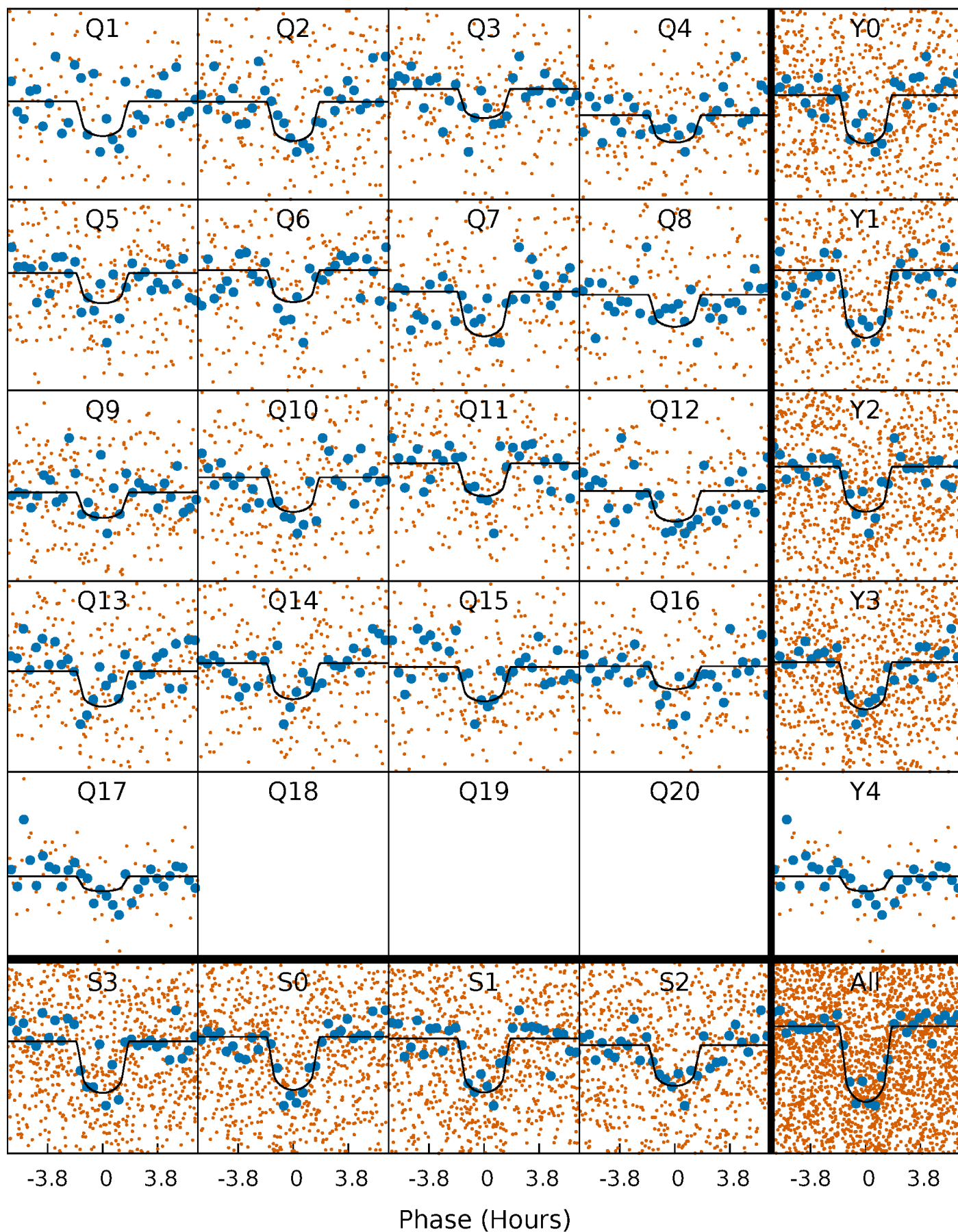
TCE 010019643-02   P= 7.811039 Days    $T_0=132.300752$  (BKJD)





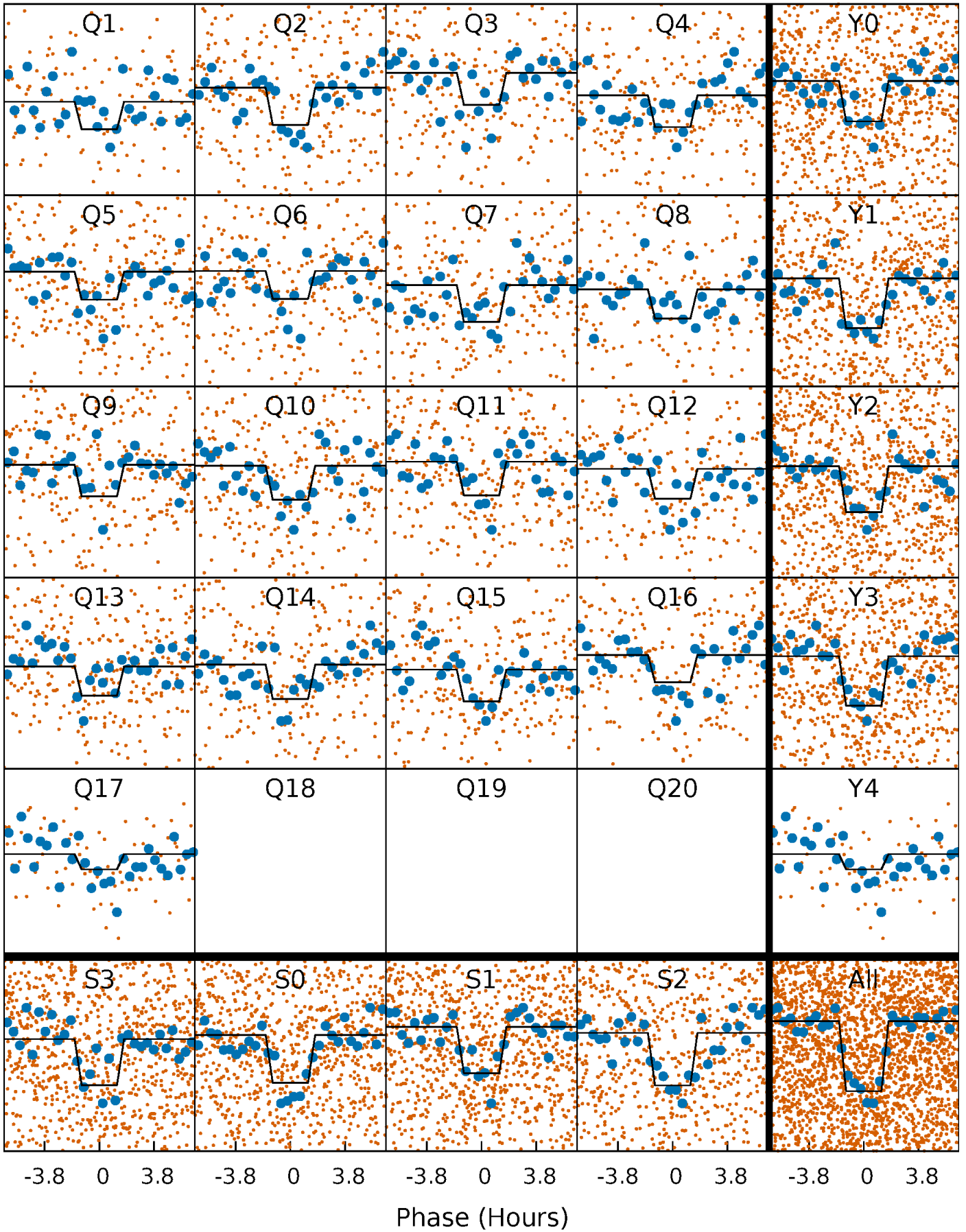
# DV Quarter-Phased Transit Curves

TCE 010019643-02 P= 7.811039 Days  $T_0=132.300752$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

TCE 010019643-02 P= 7.810976 Days  $T_0=132.305747$  (BKJD)

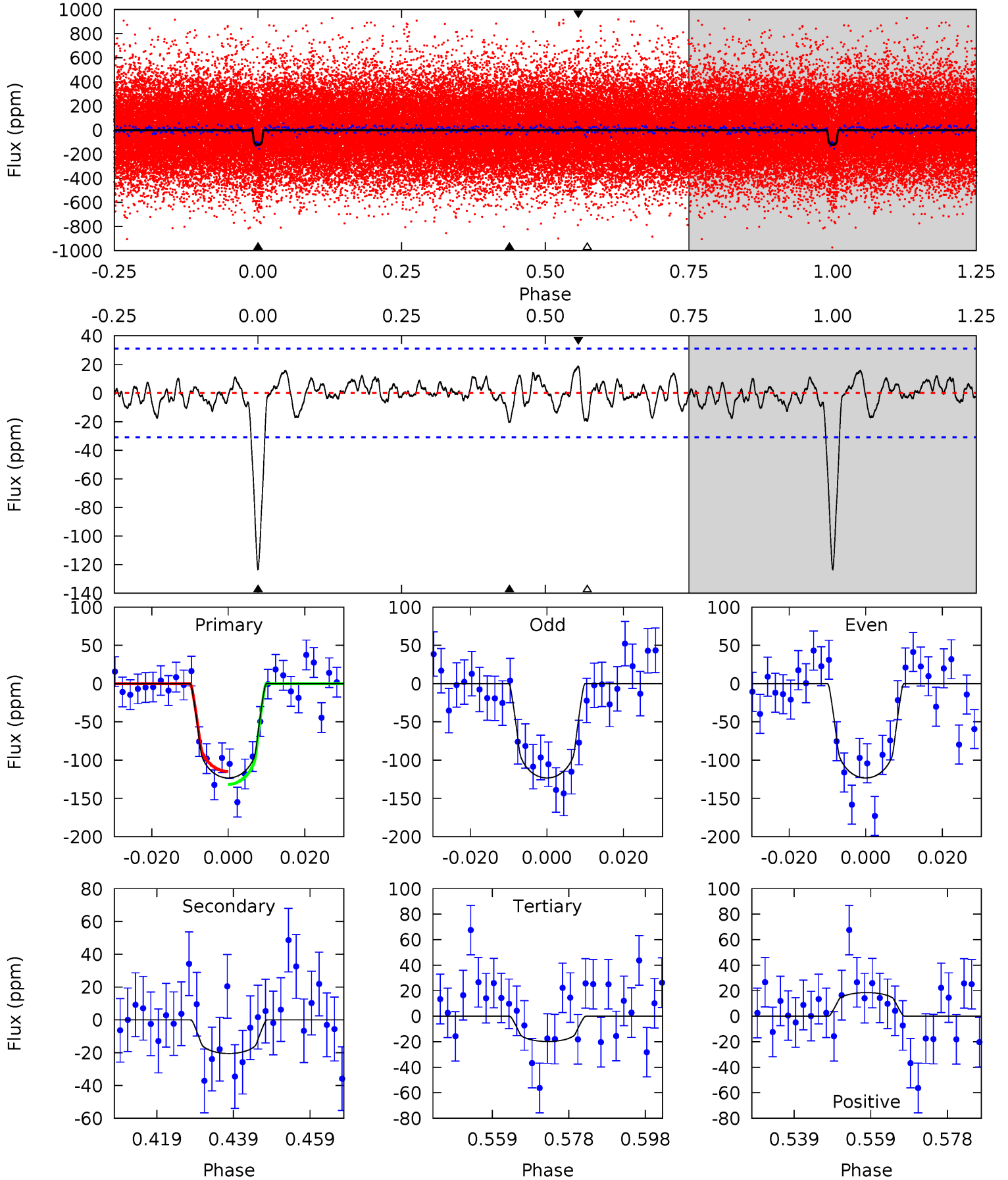




# DV Model-Shift Uniqueness Test

010019643-02, P = 7.811039 Days, E = 124.489713 Days

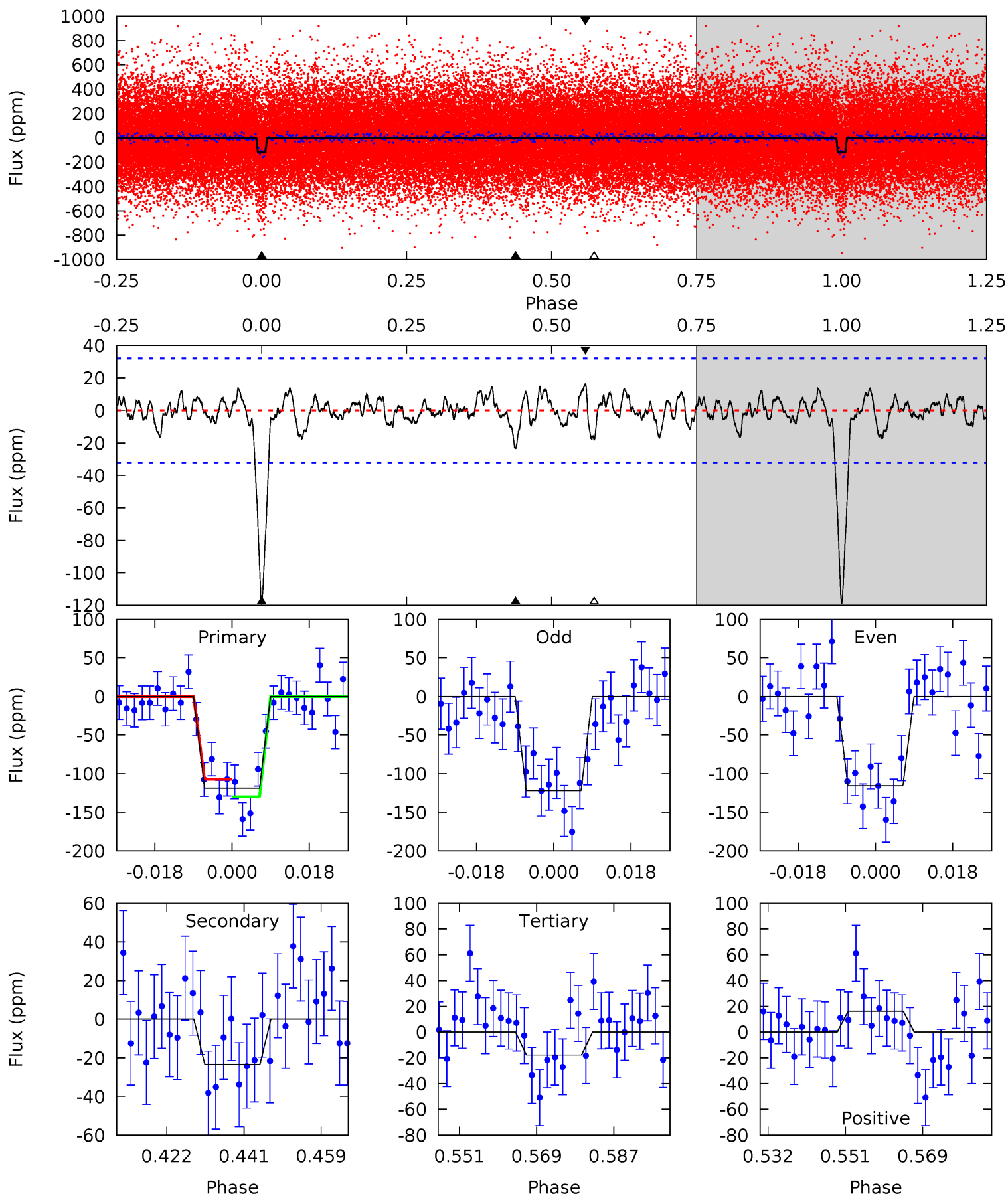
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
19.5	3.24	3.13	2.92	4.89	2.33	1.09	16.3	16.5	0.11	0.32	0.00	0.99	0.13	1.34



# Alt Model-Shift Uniqueness Test

010019643-02, P = 7.810976 Days, E = 124.494771 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
18.2	3.60	2.73	2.48	4.91	2.36	0.99	15.5	15.7	0.87	1.11	0.46	1.04	0.12	1.74



### Stellar Parameters For KIC 010019643

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R$ ( $R_{\odot}$ )	$M(M_{\odot})$	$p_{\star}$ ( $\text{g}\cdot\text{cm}^{-3}$ )
	$5395^{+80}_{-72}$	$4.324^{+0.154}_{-0.112}$	$0.160^{+0.150}_{-0.100}$	$1.071^{+0.180}_{-0.180}$	$0.882^{+0.065}_{-0.032}$	$1.012^{+0.703}_{-0.353}$
	+1%/-1%	+4%/-3%	+94%/-62%	+17%/-17%	+7%/-4%	+69%/-35%
Source	SPE90	SPE90	SPE90	DSEP		

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

### Secondary Eclipse Parameters for KIC 010019643-02 / KOI 0471.02

Detrend	Depth (ppm)	$R_p$ ( $R_{\oplus}$ )	$T_{max}$ (K)	$T_{obs}$ (K)	$A_{obs}$
DV	$-21 \pm 6$	$1.43^{+0.81}_{-0.73}$	$1261^{+60}_{-66}$	$3653^{+1119}_{-509}$	$28^{+103}_{-17}$
Alt.	$-23 \pm 7$	$1.29^{+0.84}_{-0.68}$	$1263^{+59}_{-60}$	$3882^{+1312}_{-611}$	$43^{+146}_{-29}$

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

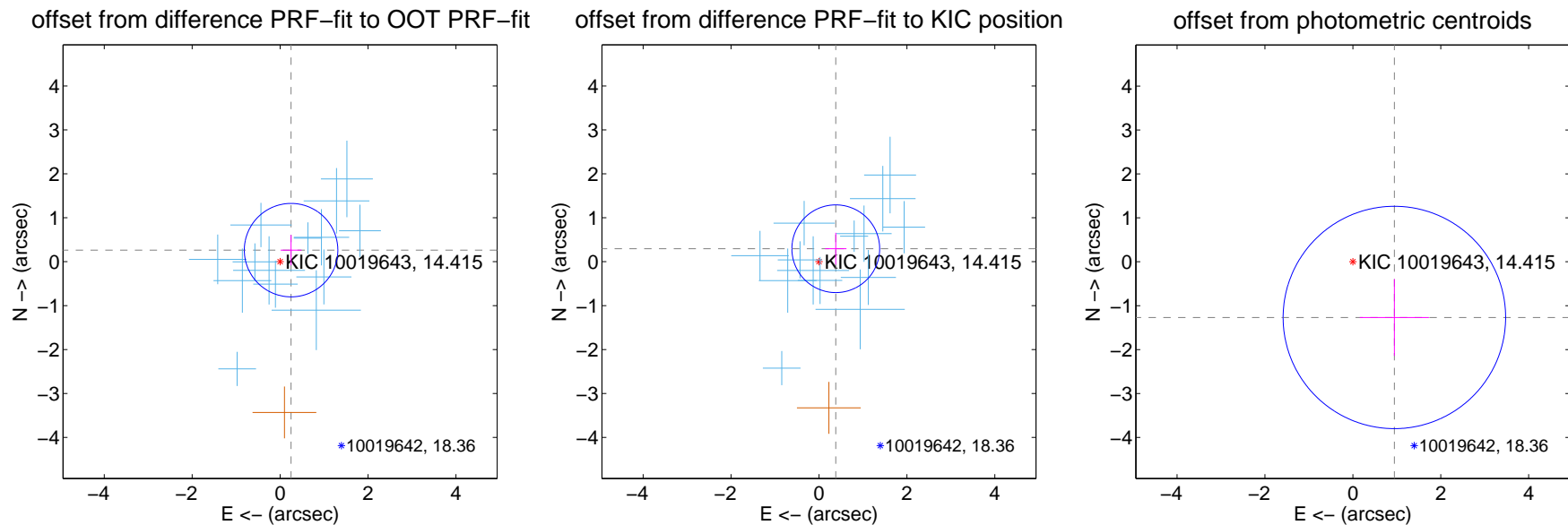
## DV Centroid Data

Supplemental centroid analysis for 010019643-02. Kepler magnitude: 14.41. Transit SNR 14.45

There are 14 quarters with good PRF difference image offsets

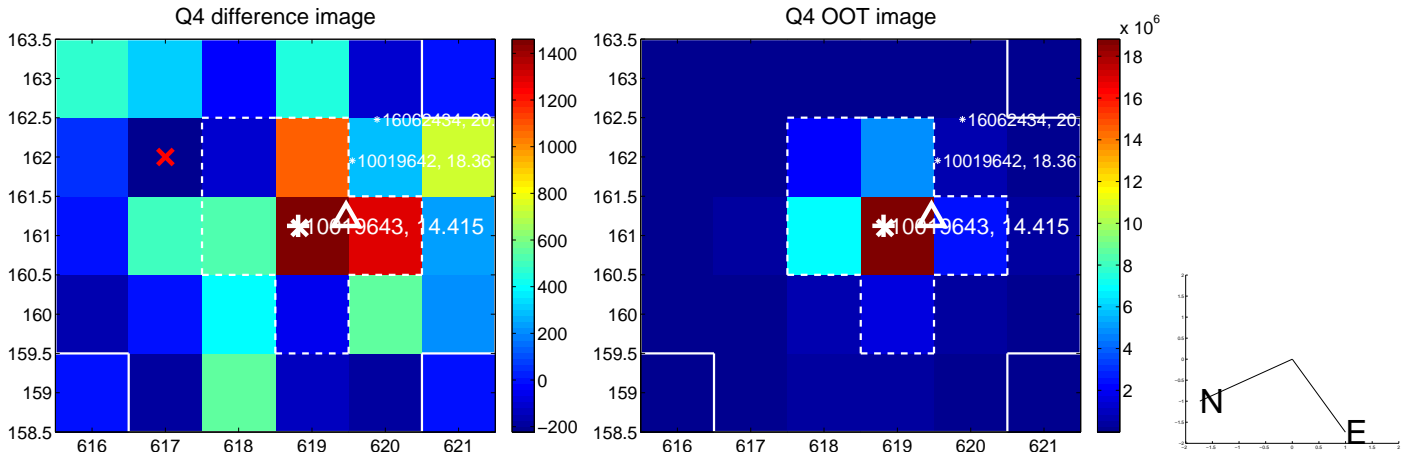
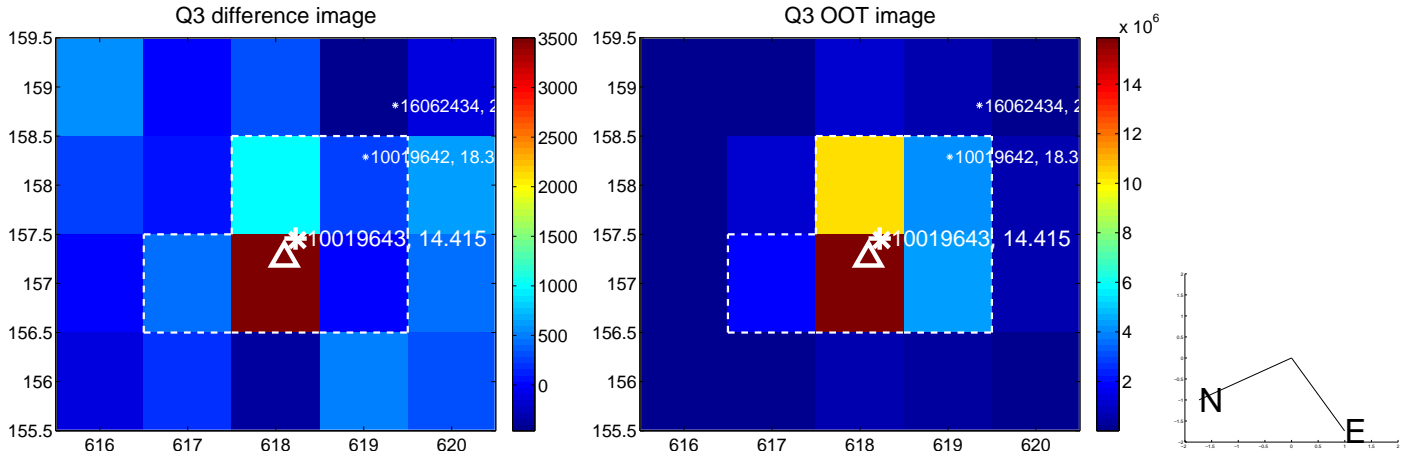
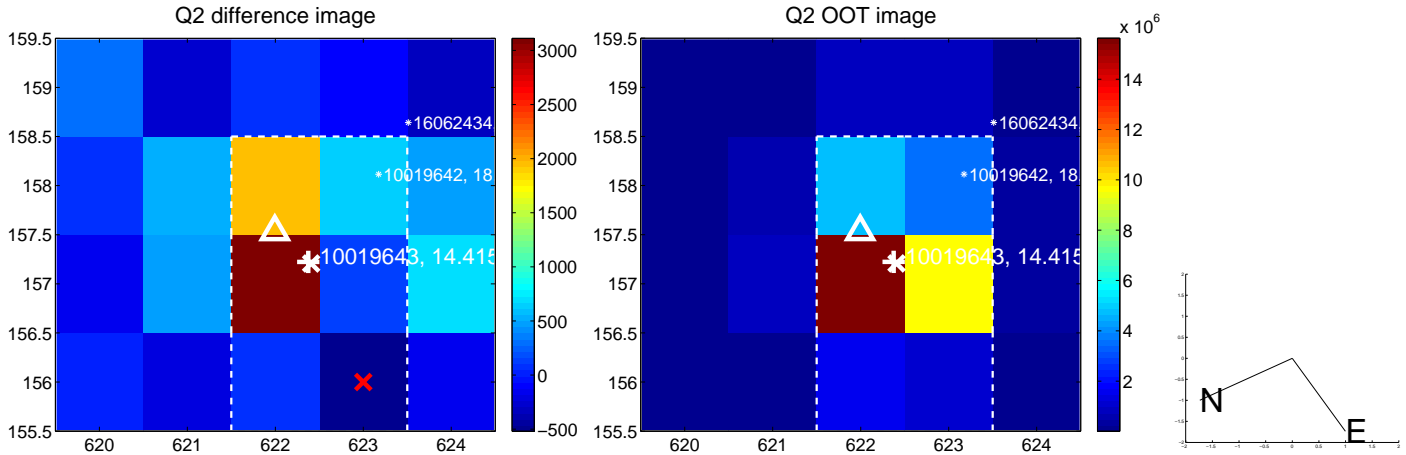
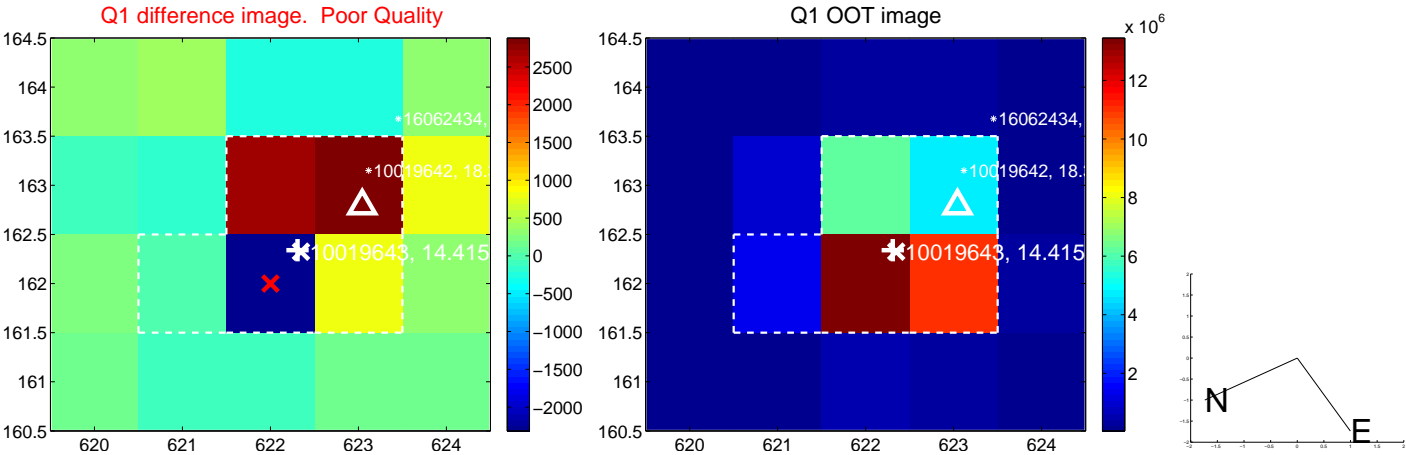
The direct PRF centroid is offset from the target star catalog position by about 0.13 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.363 \pm 0.354$	1.02	$-0.249 \pm 0.238$	$0.263 \pm 0.346$
PRF-fit source offset from KIC position	$0.482 \pm 0.333$	1.45	$-0.382 \pm 0.242$	$0.295 \pm 0.361$
photometric centroid source offset	$1.58 \pm 0.84$	1.87	$-0.94 \pm 0.79$	$-1.27 \pm 0.87$

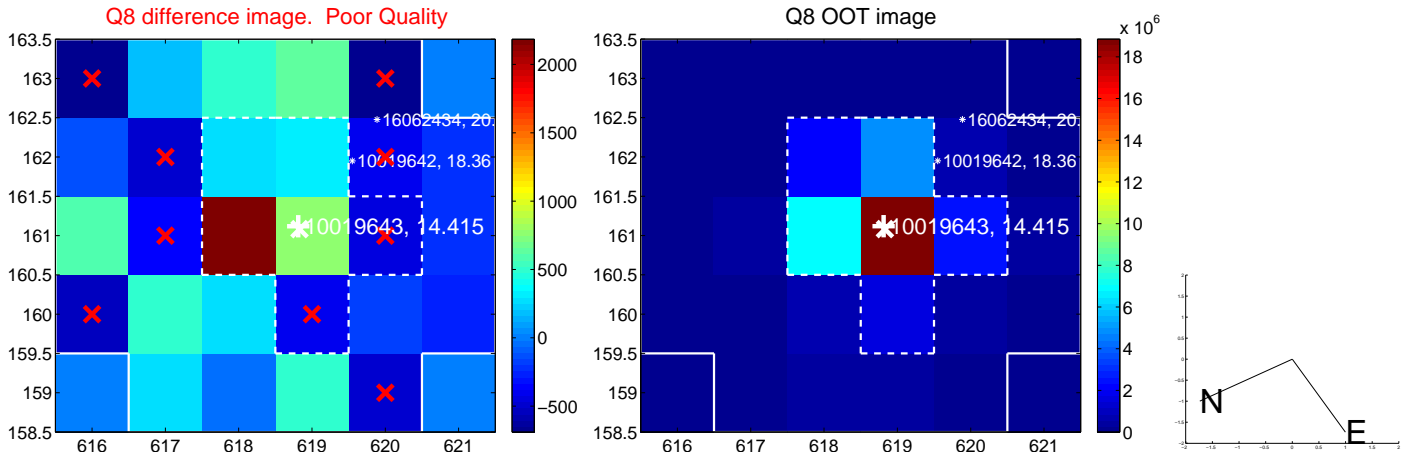
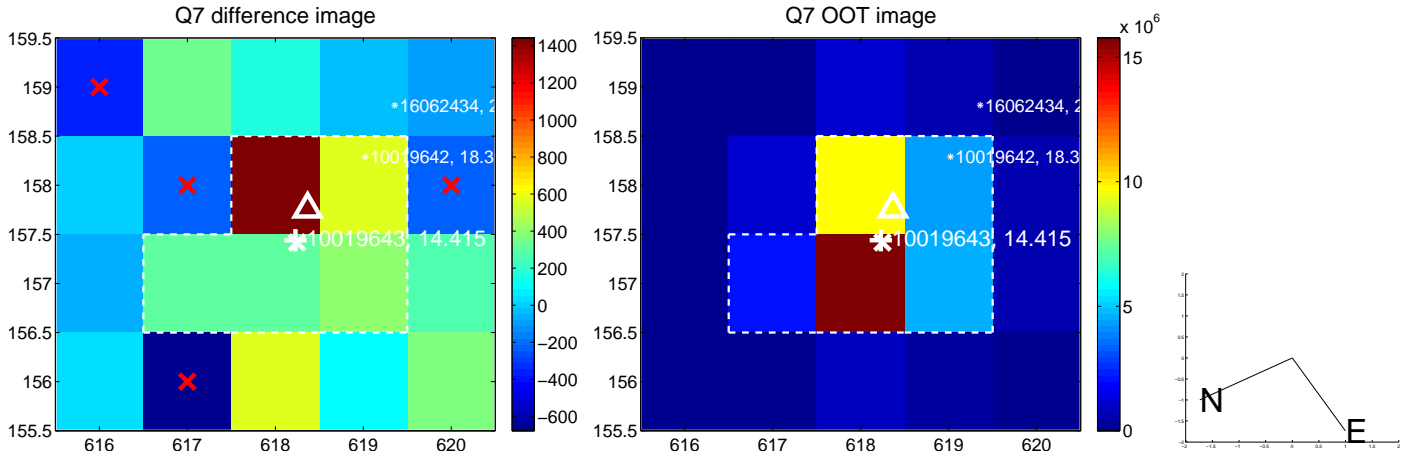
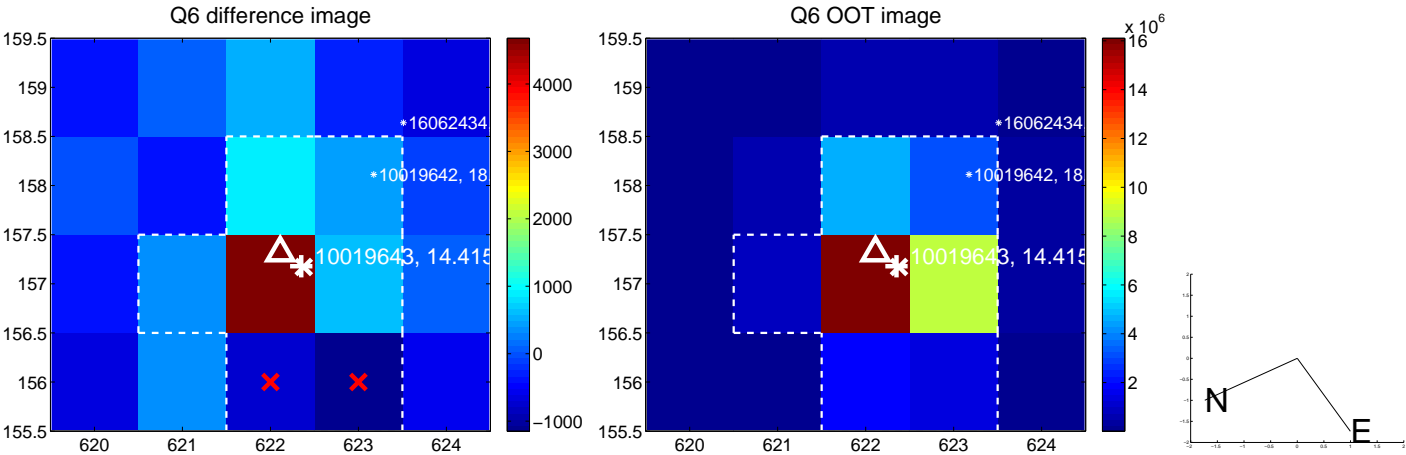
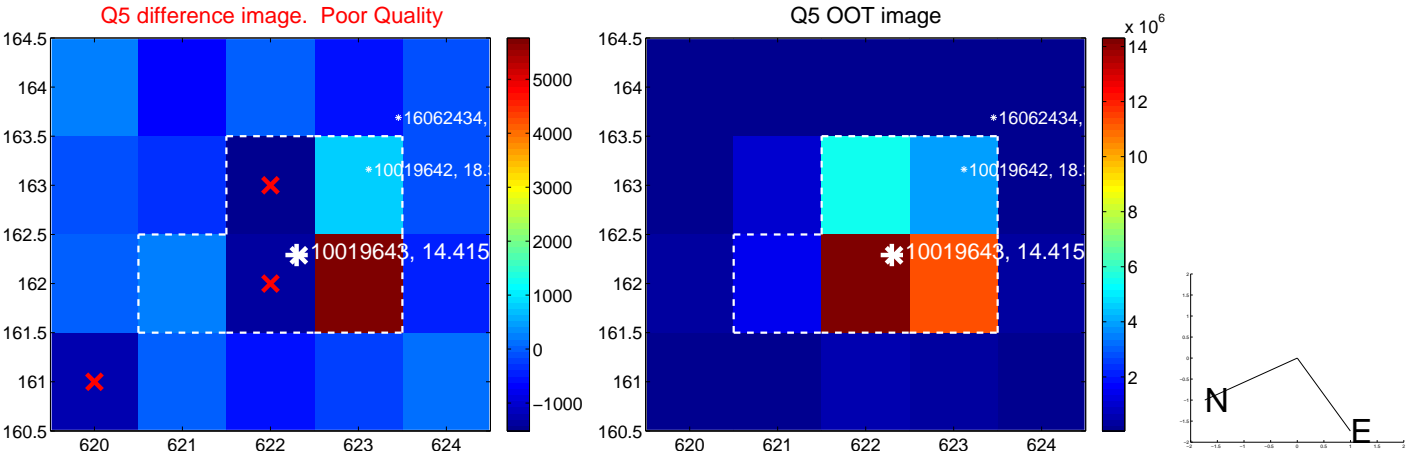


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses:** good quarterly centroid offsets; **Vermillion crosses:** bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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

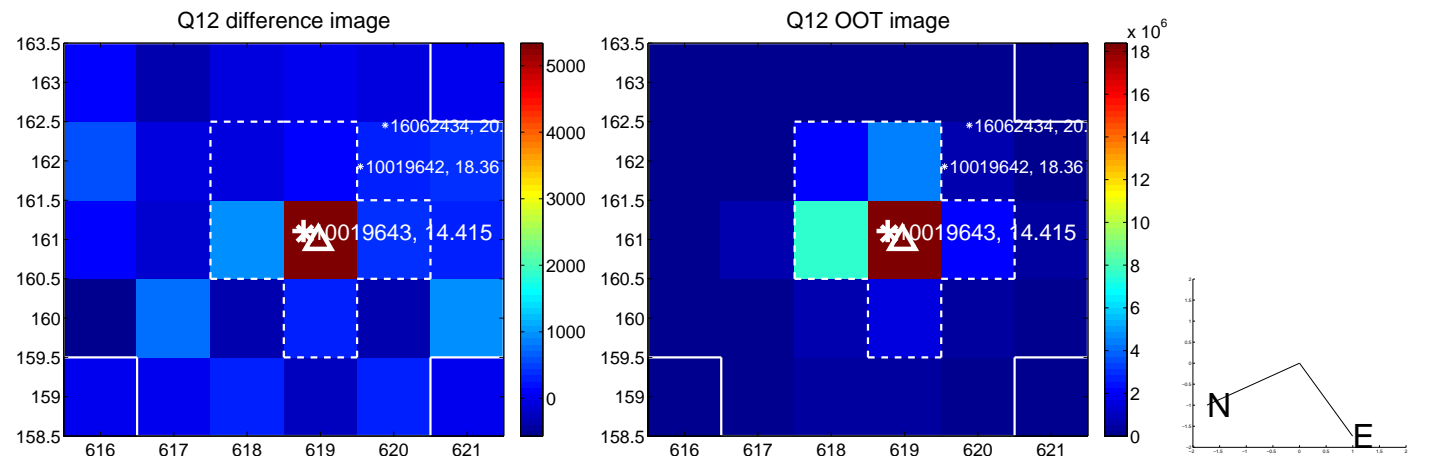
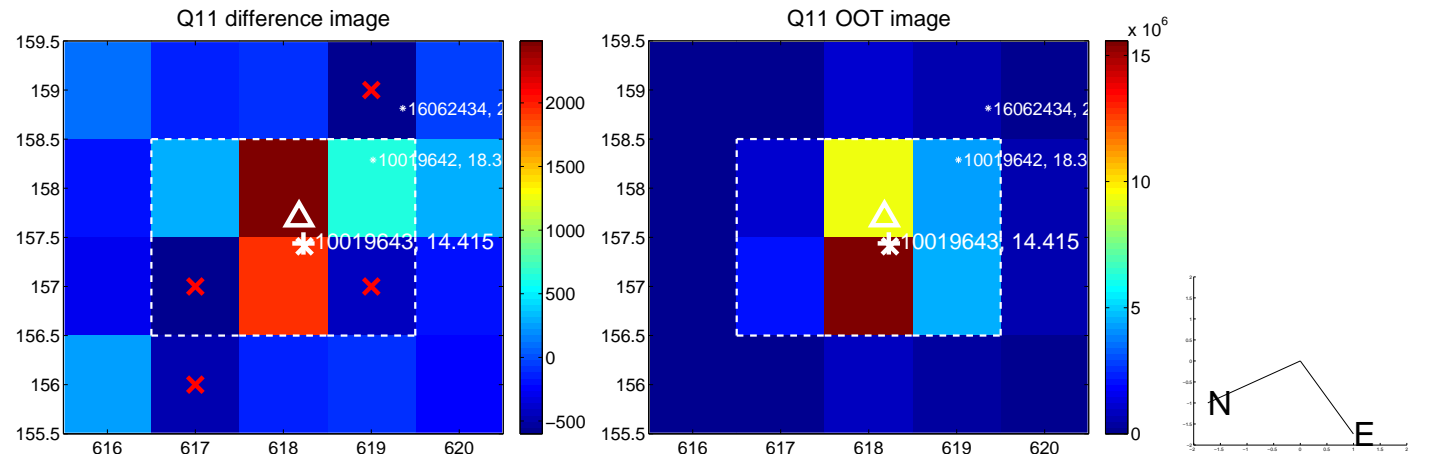
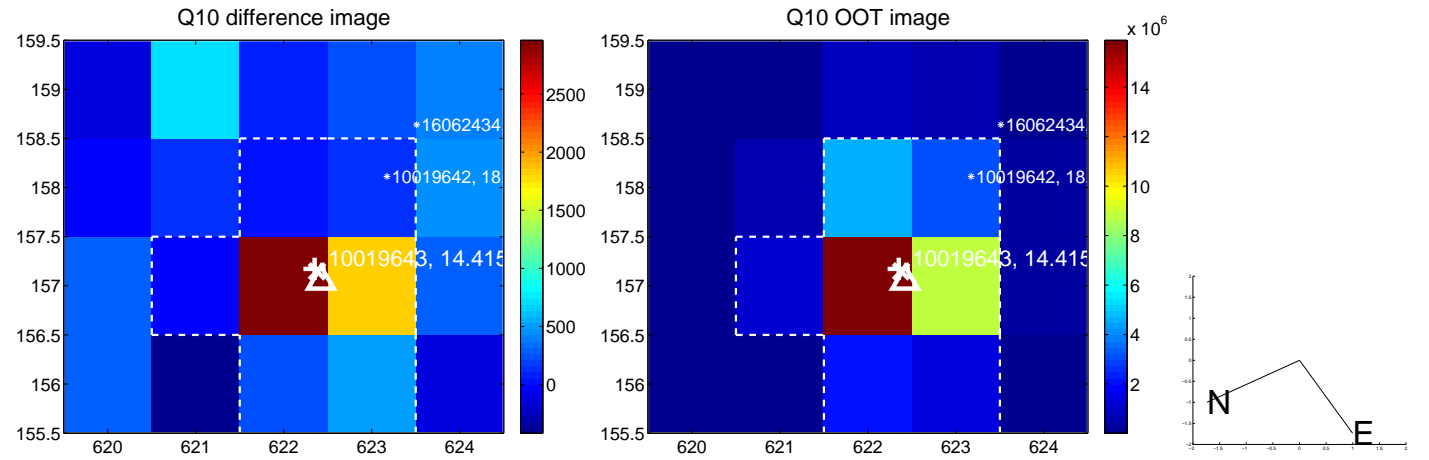
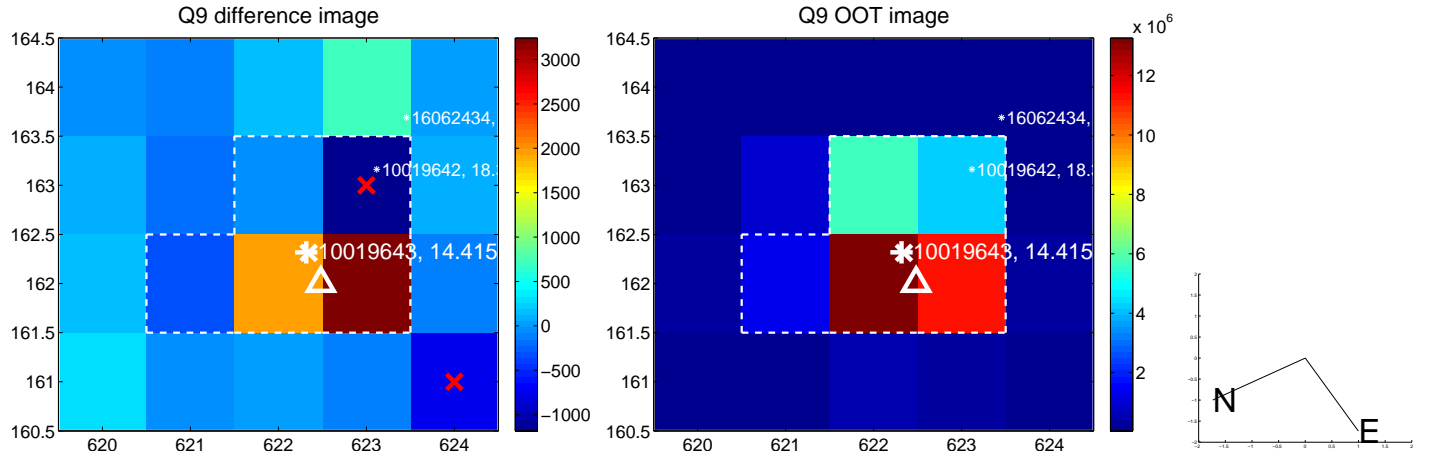
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

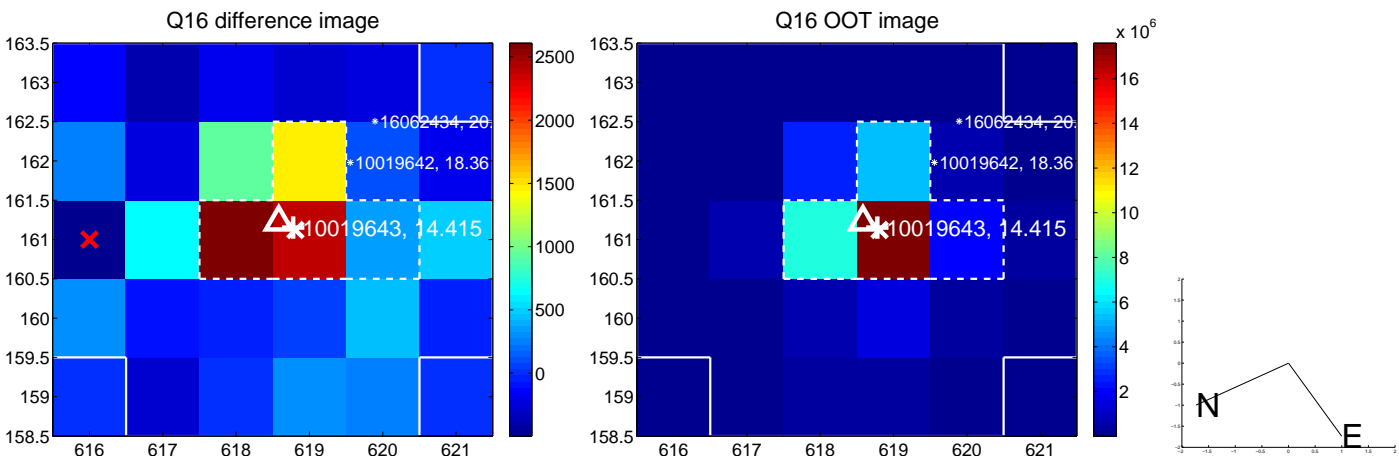
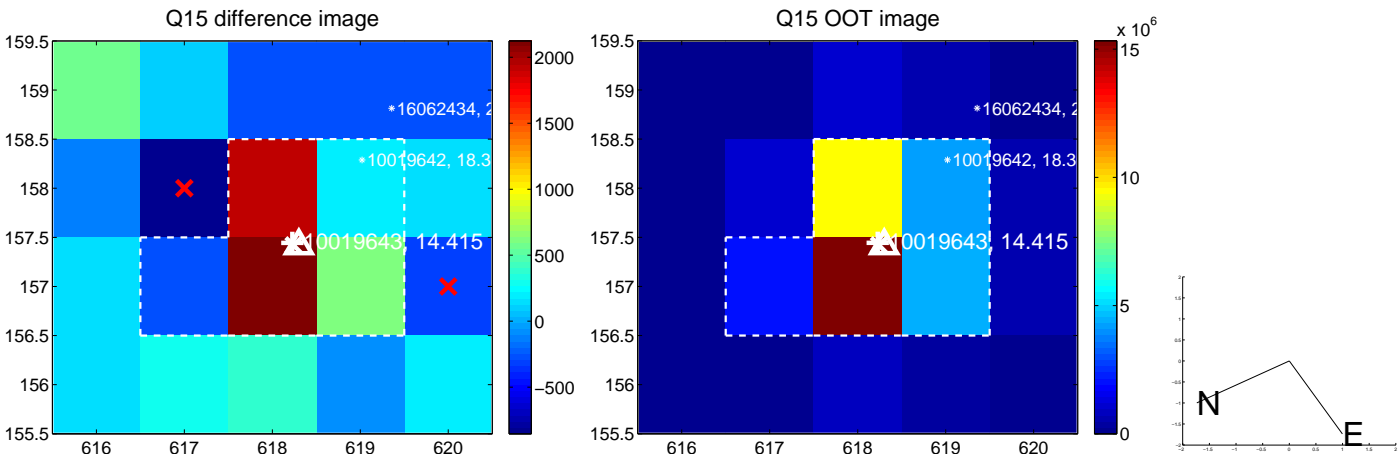
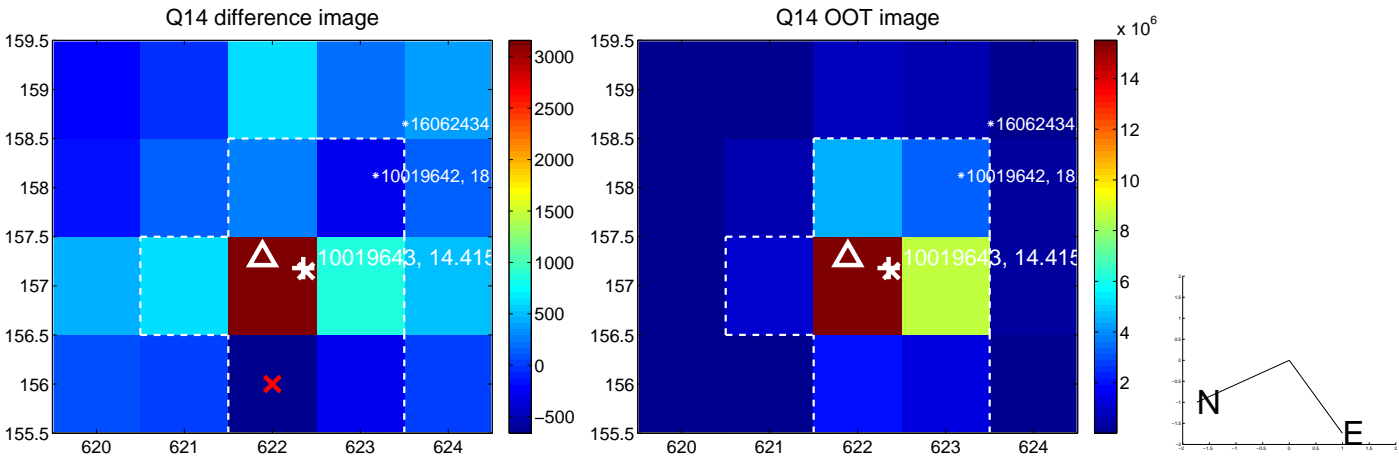
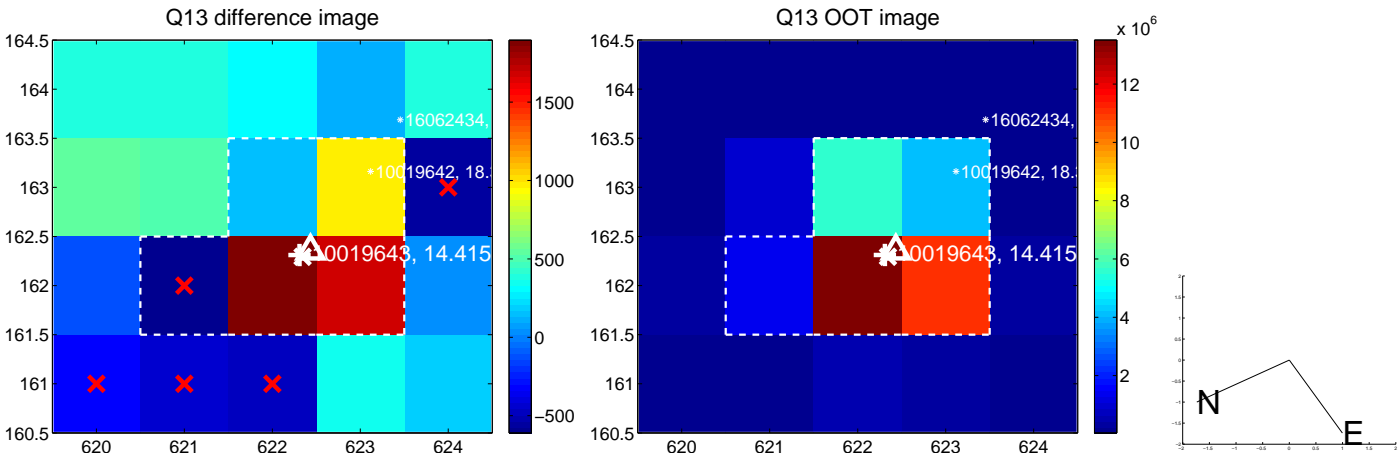


white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

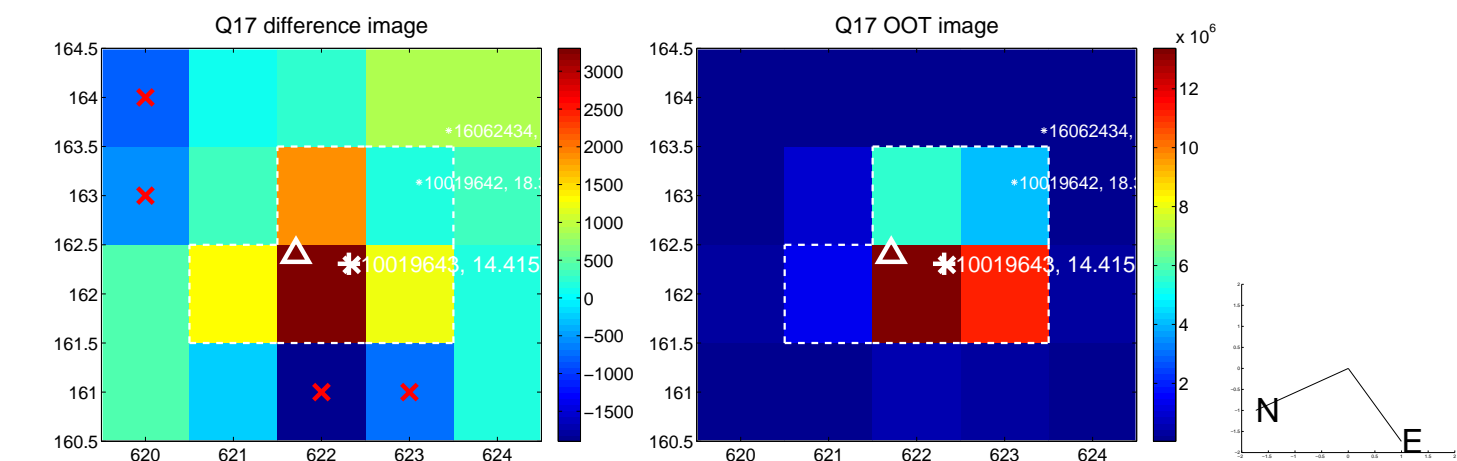




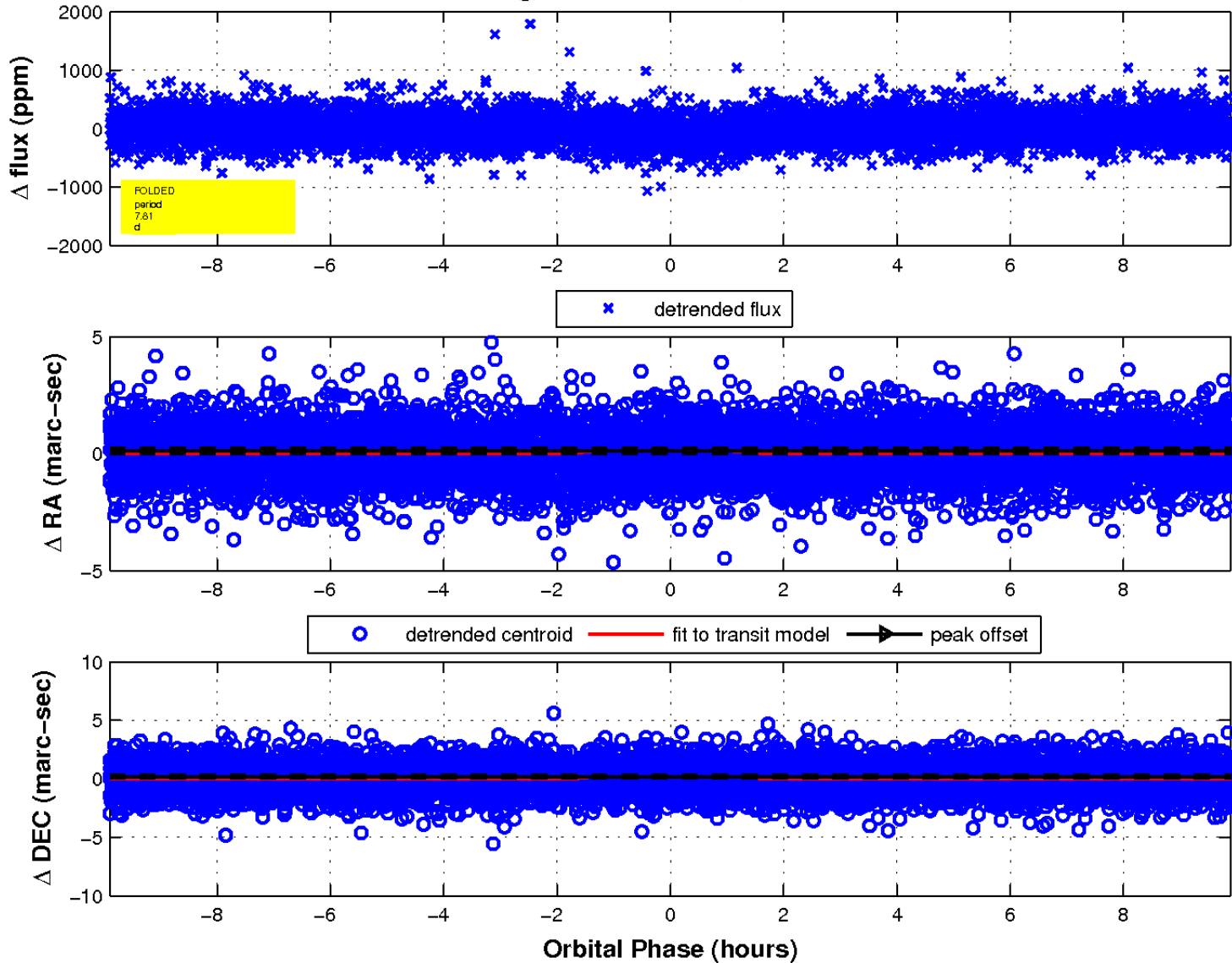
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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



### fluxWeightedCentroids, Planet 2 of 2



UKIRT Image

Declination

