

# KIC 009786821

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
009786821-01	OBS	7230.01	21.120005	150.128424	12899.2	2.052	1668.1	1642.3	1.60	6195	29.14	142.07
009786821-03	OBS	No	21.119584	150.121749	403.4	36.937	18.0	24.1	1.60	6195	6.29	142.08

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
009786821-01	OBS	FP	0.00	0	1	0	0	DEEP_V_SHAPED
009786821-03	OBS	FP	0.00	1	0	0	0	LPP_DV—RESIDUAL_TCE

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

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

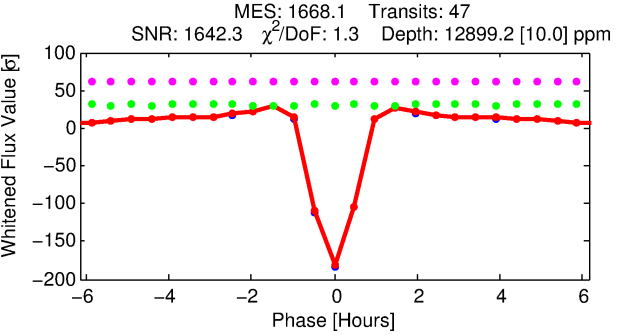
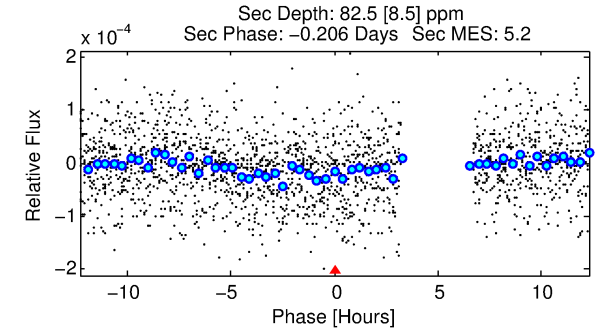
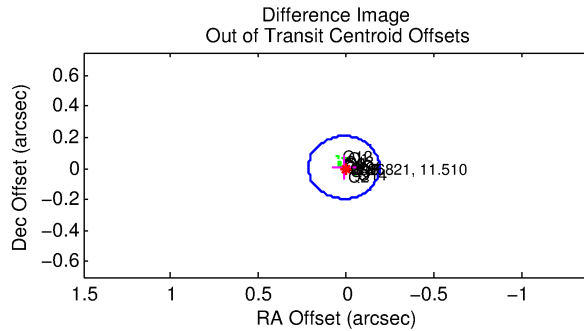
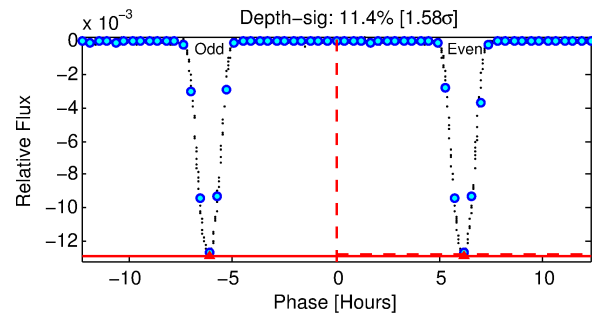
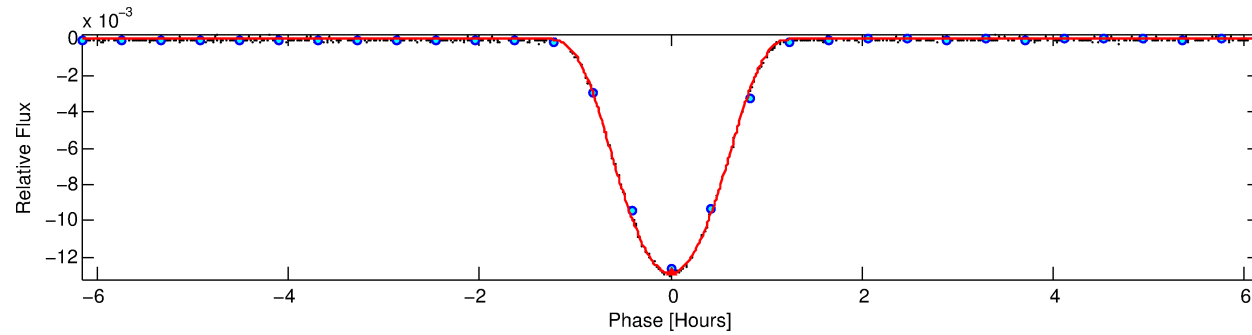
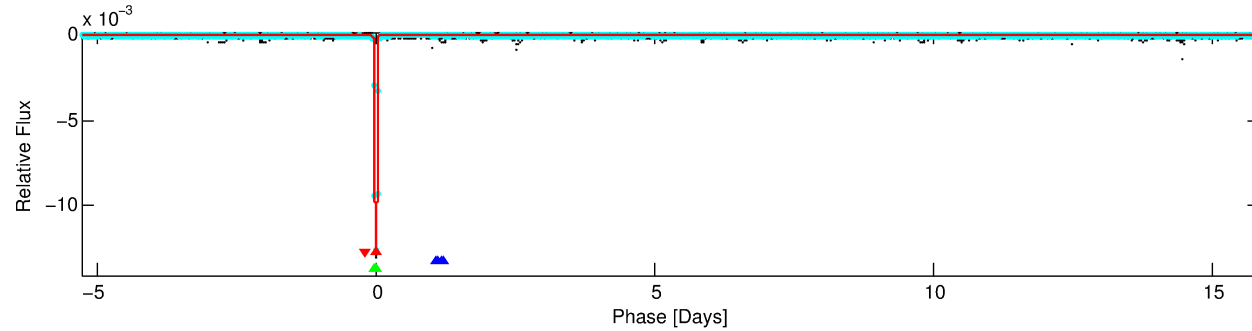
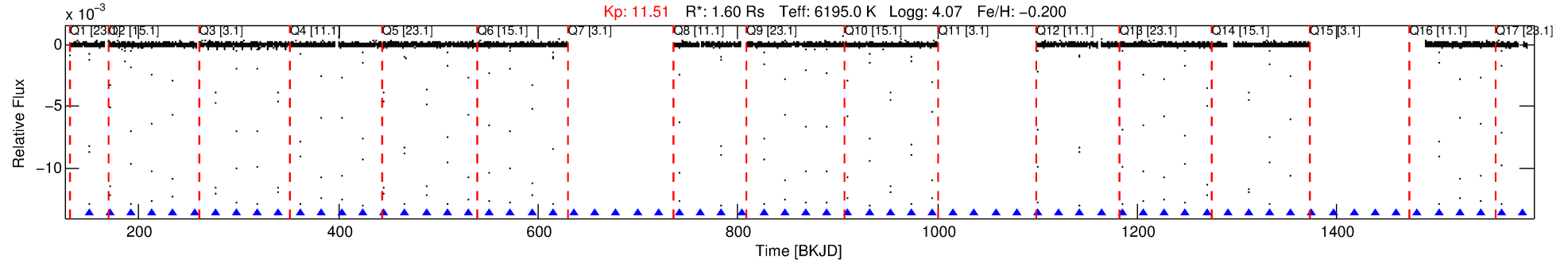
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 009786821-01

No Significant Match Found

# DV One-Page Summary

KIC: 9786821 Candidate: 1 of 3 Period: 21.120 d  
KOI: K07230.01 Corr: 1.000



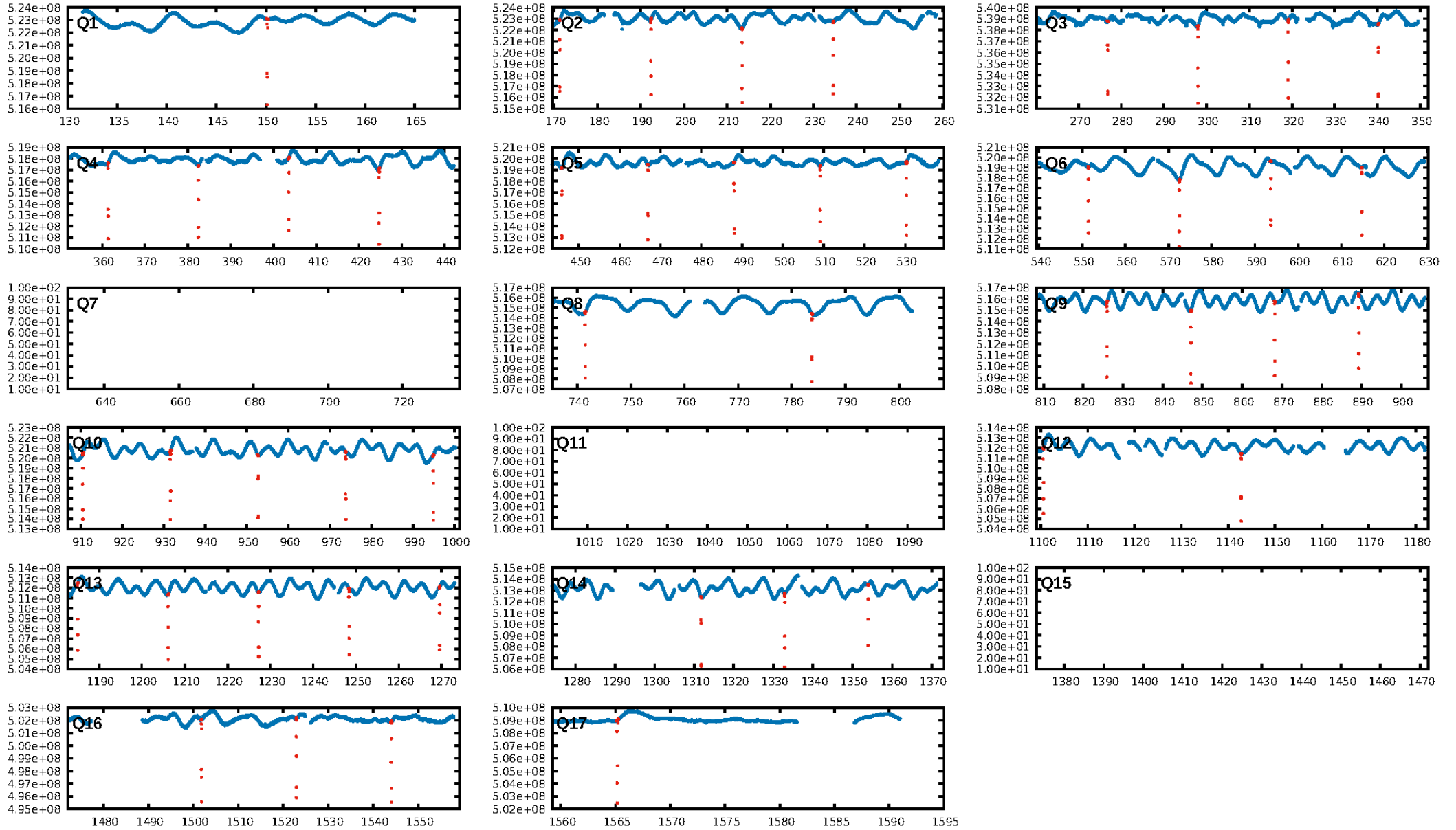
## DV Fit Results:

Period = 21.12000 [0.00000] d  
Epoch = 150.1284 [0.0000] BKJD  
 $R_p/R^* = 0.1671$  [0.0054]  
 $a/R^* = 50.82$  [0.30]  
 $b = 0.97$  [0.01]  
 $S_{\text{eff}} = 142.08$  [77.25]  
 $T_{\text{eq}} = 880$  [120] K  
 $R_p = 29.14$  [9.85]  $R_e$   
 $a = 0.1540$  [0.0500] AU  
 $A_g = 1.27$  [0.68] [0.40 $\sigma$ ]  
 $T_{\text{eff}} = 1444$  [72] K [4.04 $\sigma$ ]

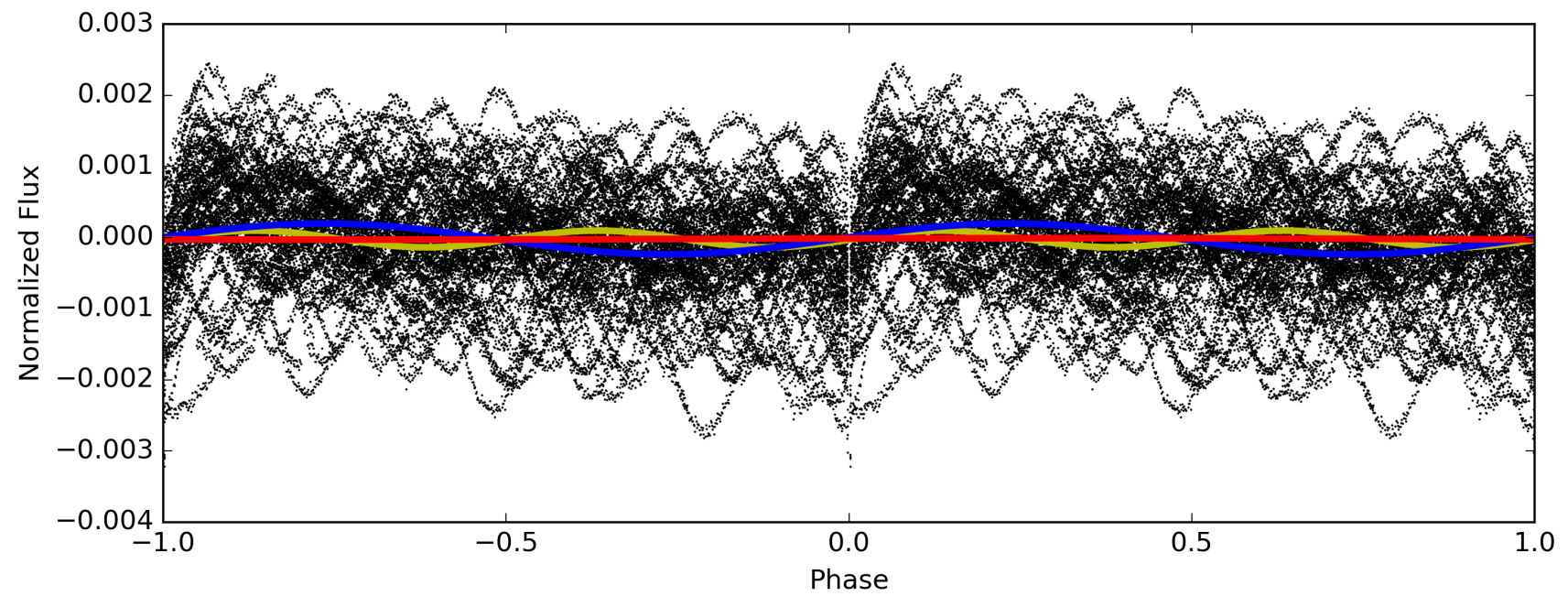
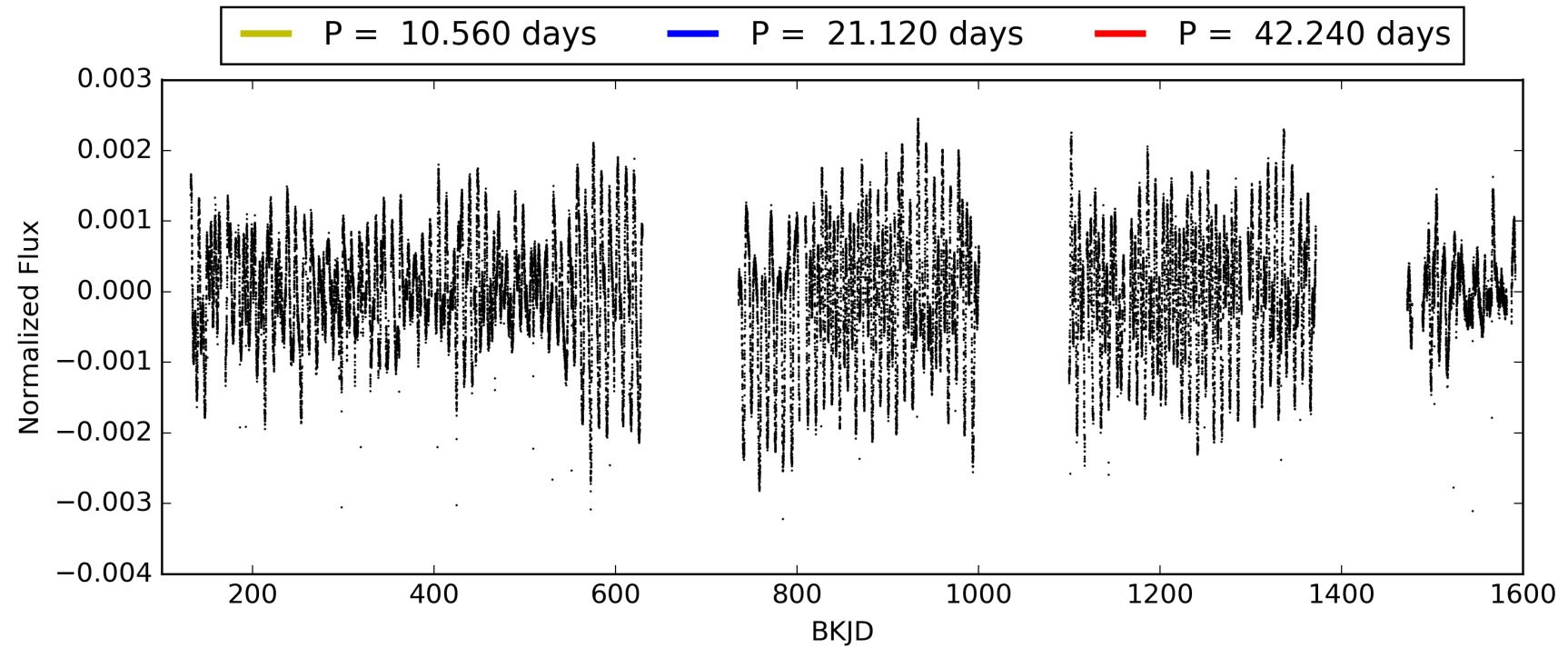
## DV Diagnostic Results:

ShortPeriod-sig: 0.0% [0.00 $\sigma$ ]  
LongPeriod-sig: 100.0% [782.30 $\sigma$ ]  
ModelChiSquare2-sig: 97.3%  
ModelChiSquareGof-sig: 70.9%  
Bootstrap-pfa: 0.00e+00  
RollingBand-fgt: 1.00 [45/45]  
GhostDiagnostic-chr: 8.344  
Centroid-sig: N/A  
Centroid-so: 0.073 arcsec [12.21 $\sigma$ ]  
OotOffset-rm: 0.016 arcsec [0.24 $\sigma$ ]  
KicOffset-rm: 0.198 arcsec [2.77 $\sigma$ ]  
OotOffset-st: 4/1/4/5 [14]  
KicOffset-st: 4/1/4/5 [14]  
DiffImageQuality-fgm: 1.00 [14/14]  
DiffImageOverlap-fno: 0.00 [0/14]

# TCE 009786821-01, PDC Light Curves

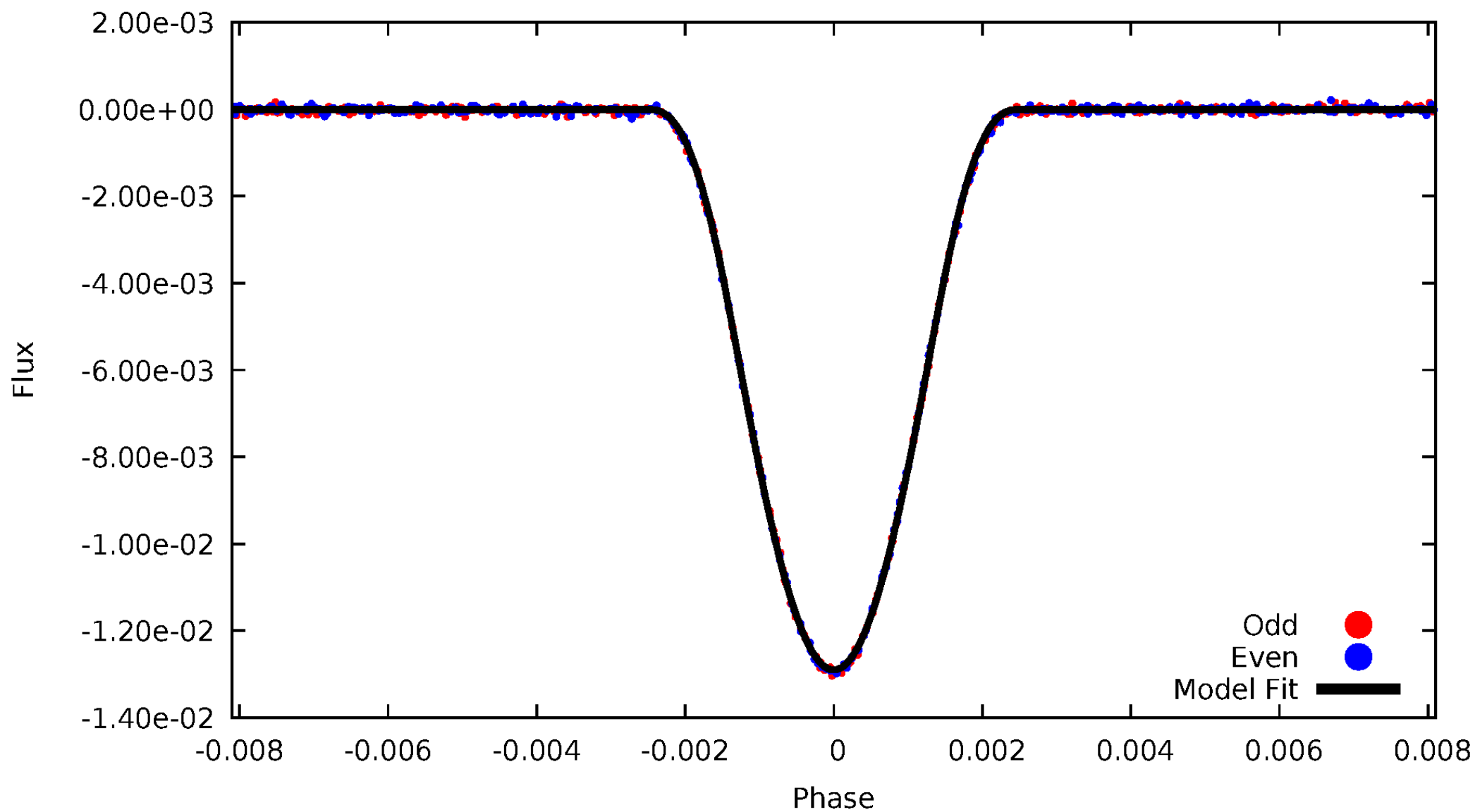


TCE 009786821-01



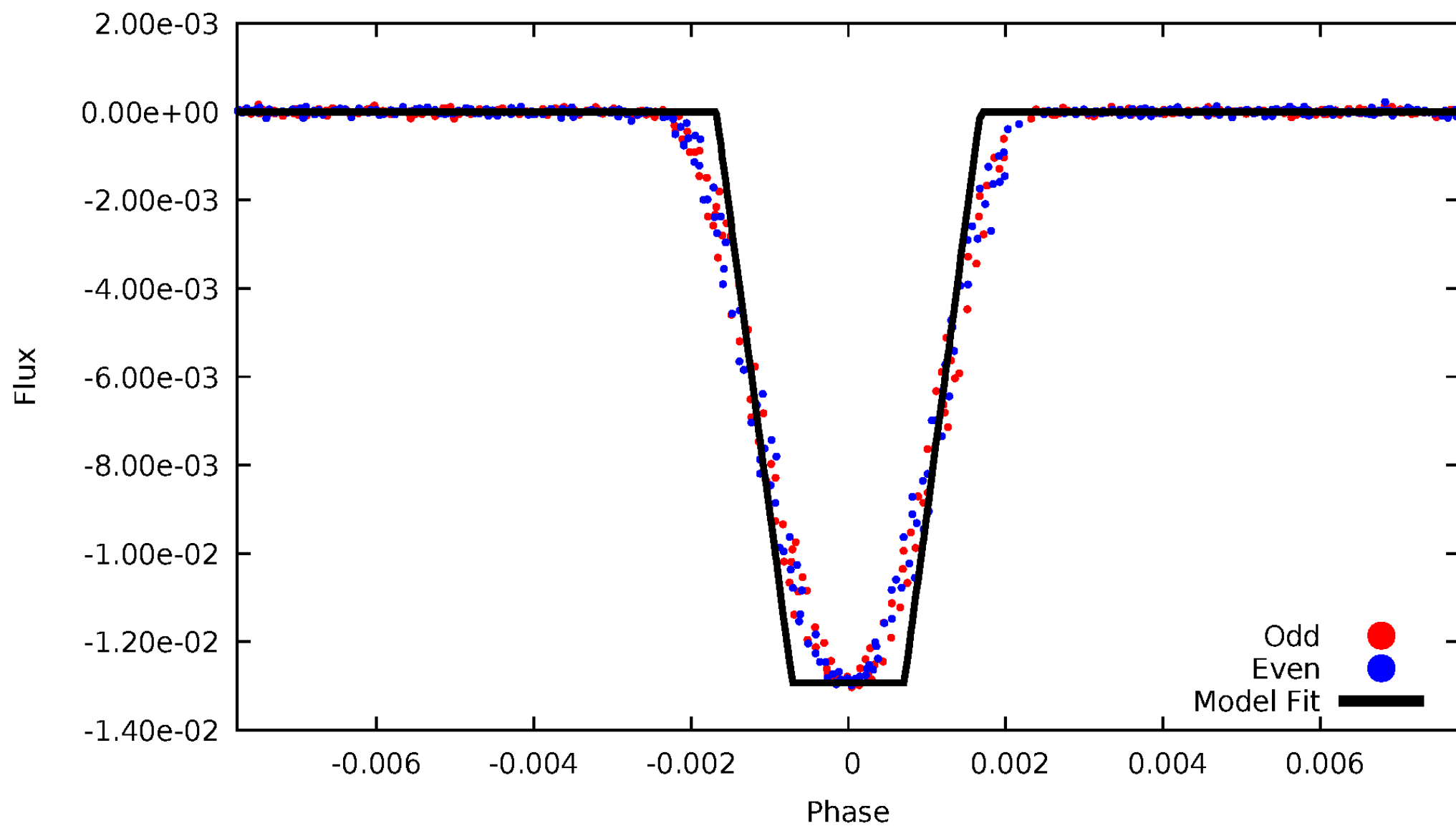
# DV Odd/Even

TCE 009786821-01

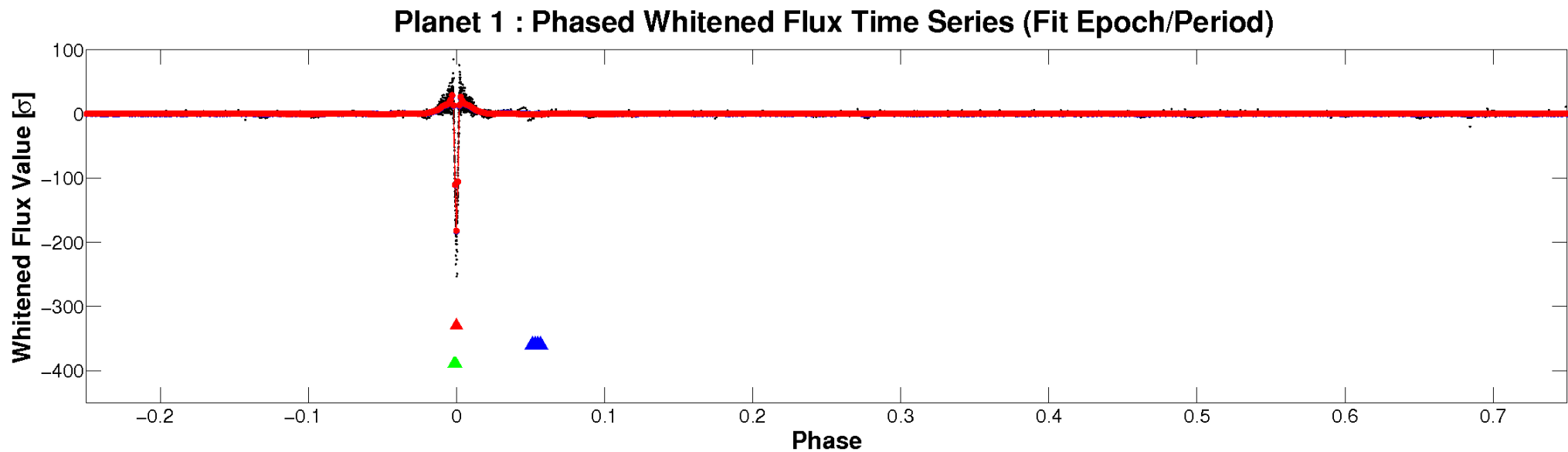
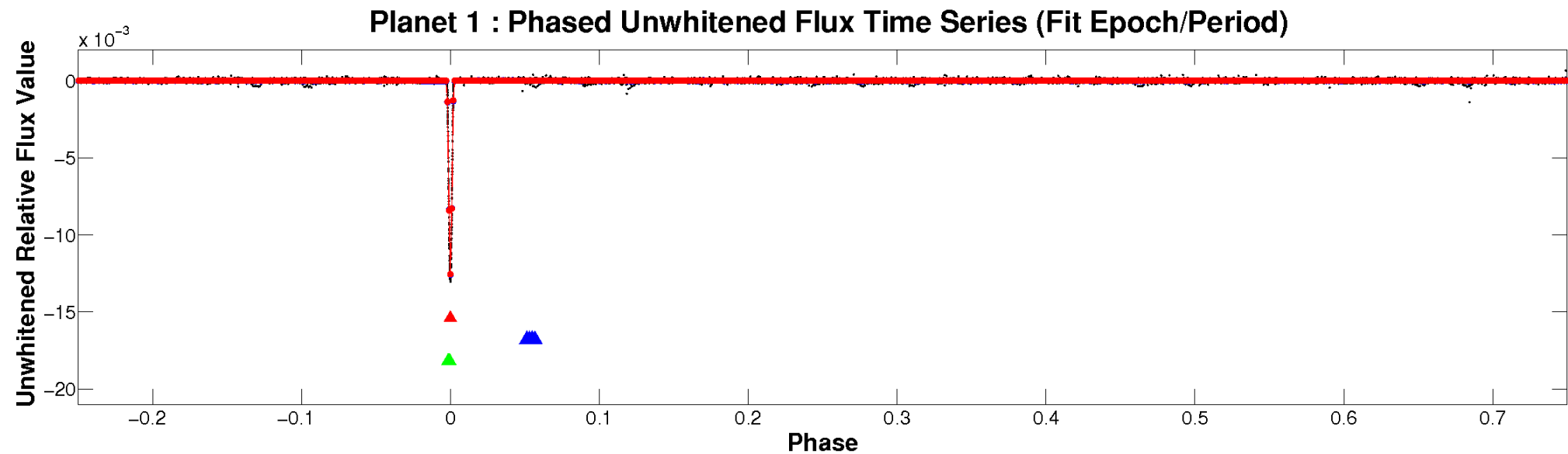


# ALT Odd/Even

TCE 009786821-01

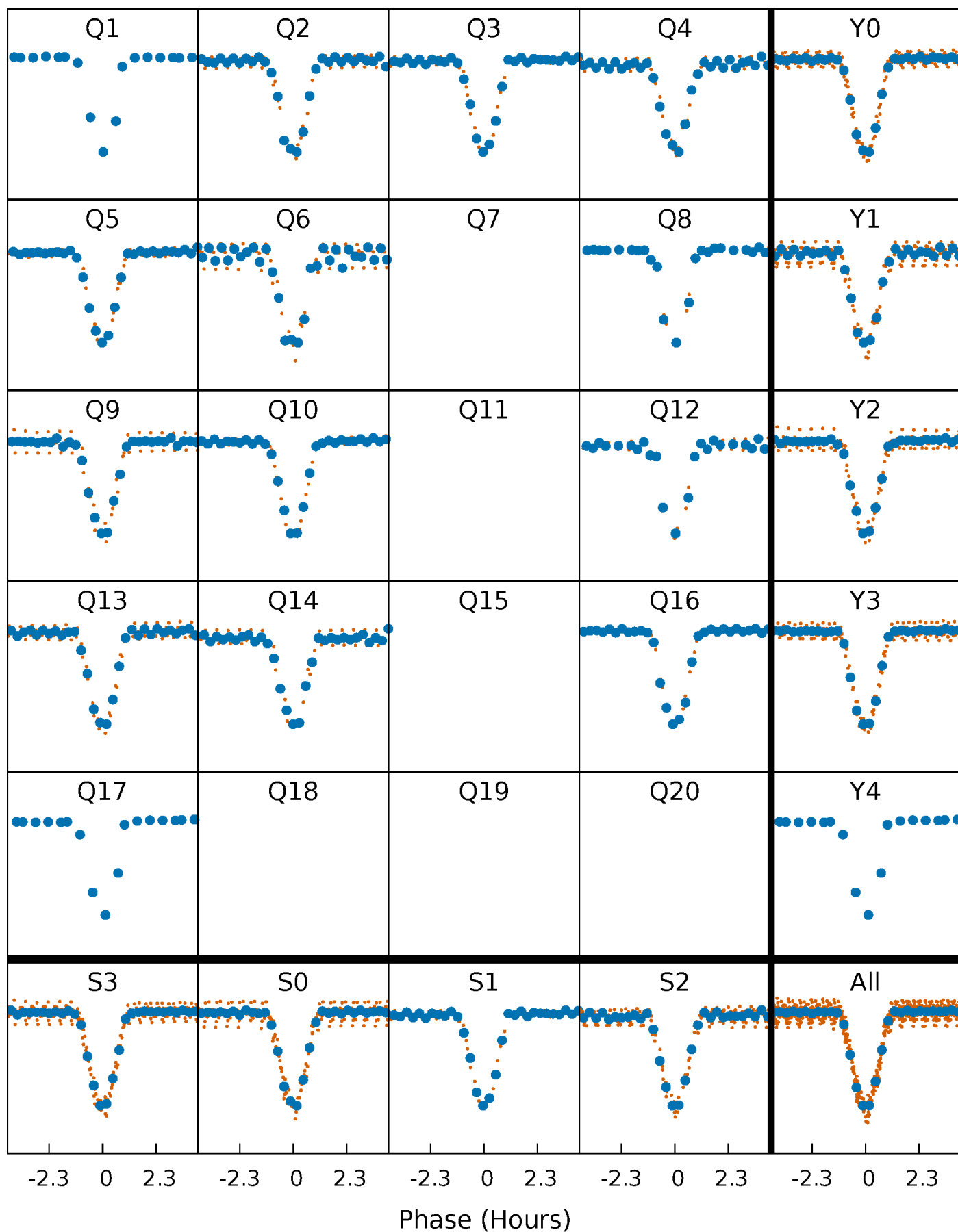


# Non-Whitened Vs. Whitened Light Curve



# PDC Quarter-Phased Transit Curves

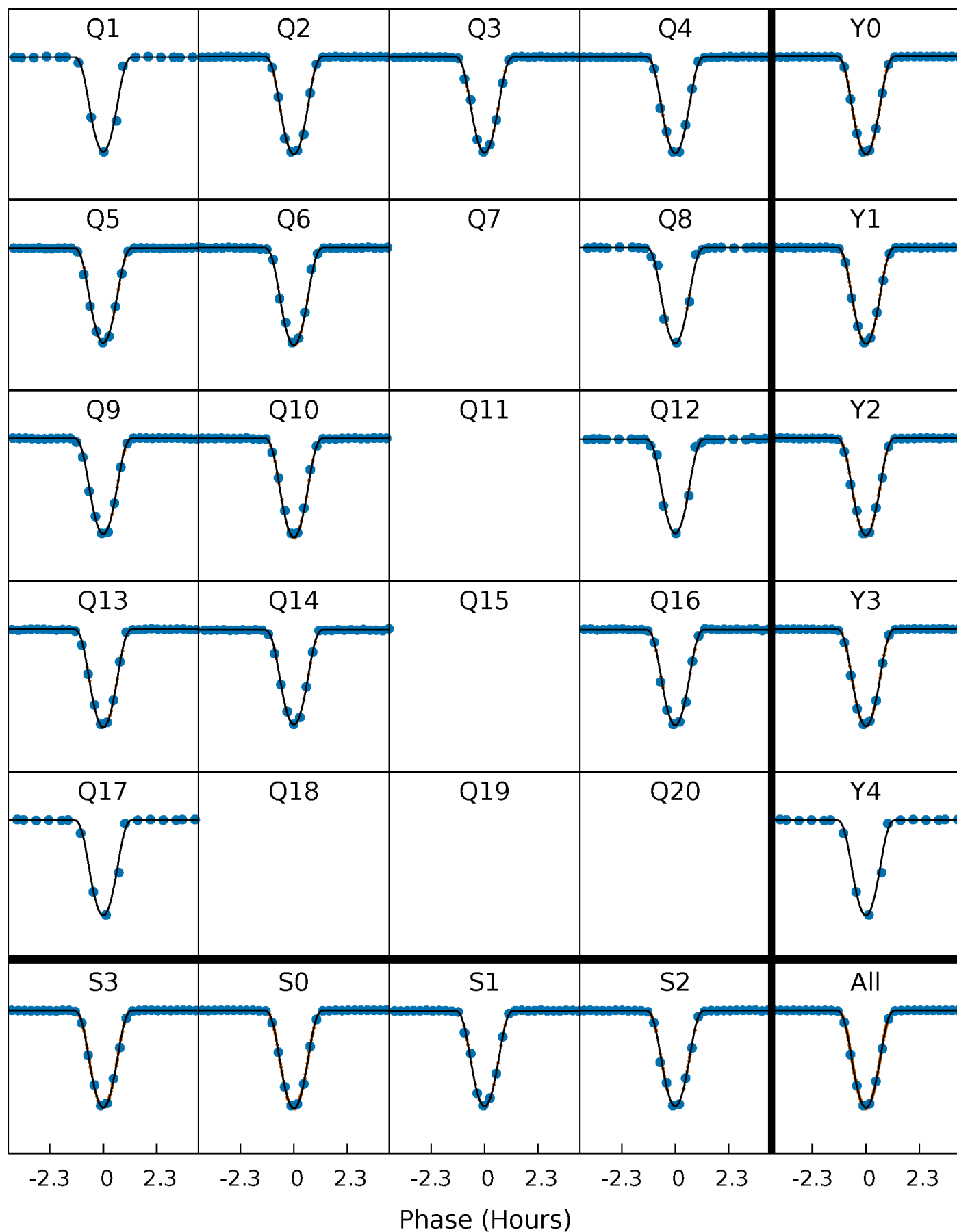
TCE 009786821-01 P= 21.120005 Days  $T_0=150.128424$  (BKJD)





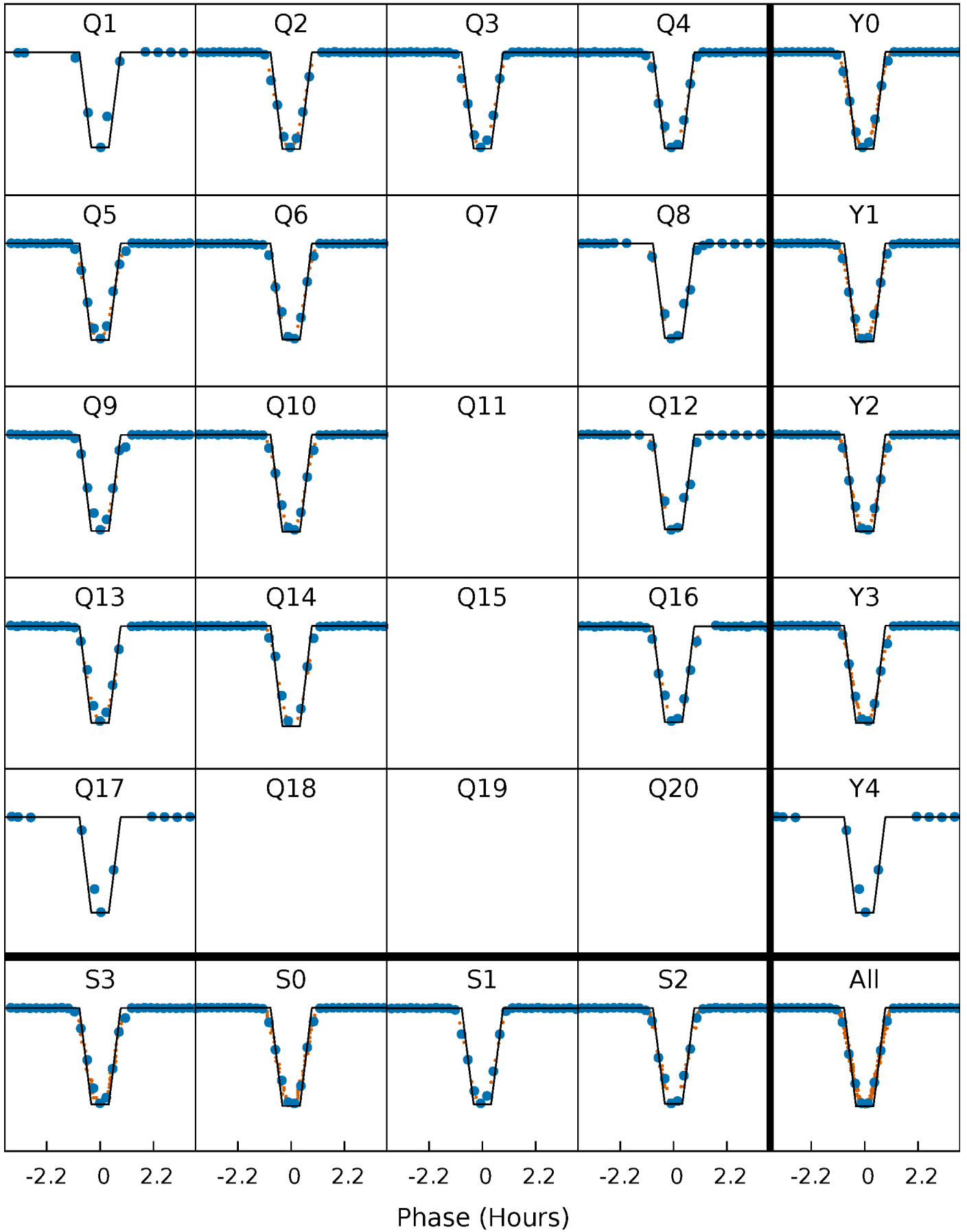
# DV Quarter-Phased Transit Curves

TCE 009786821-01 P= 21.120005 Days  $T_0=150.128424$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

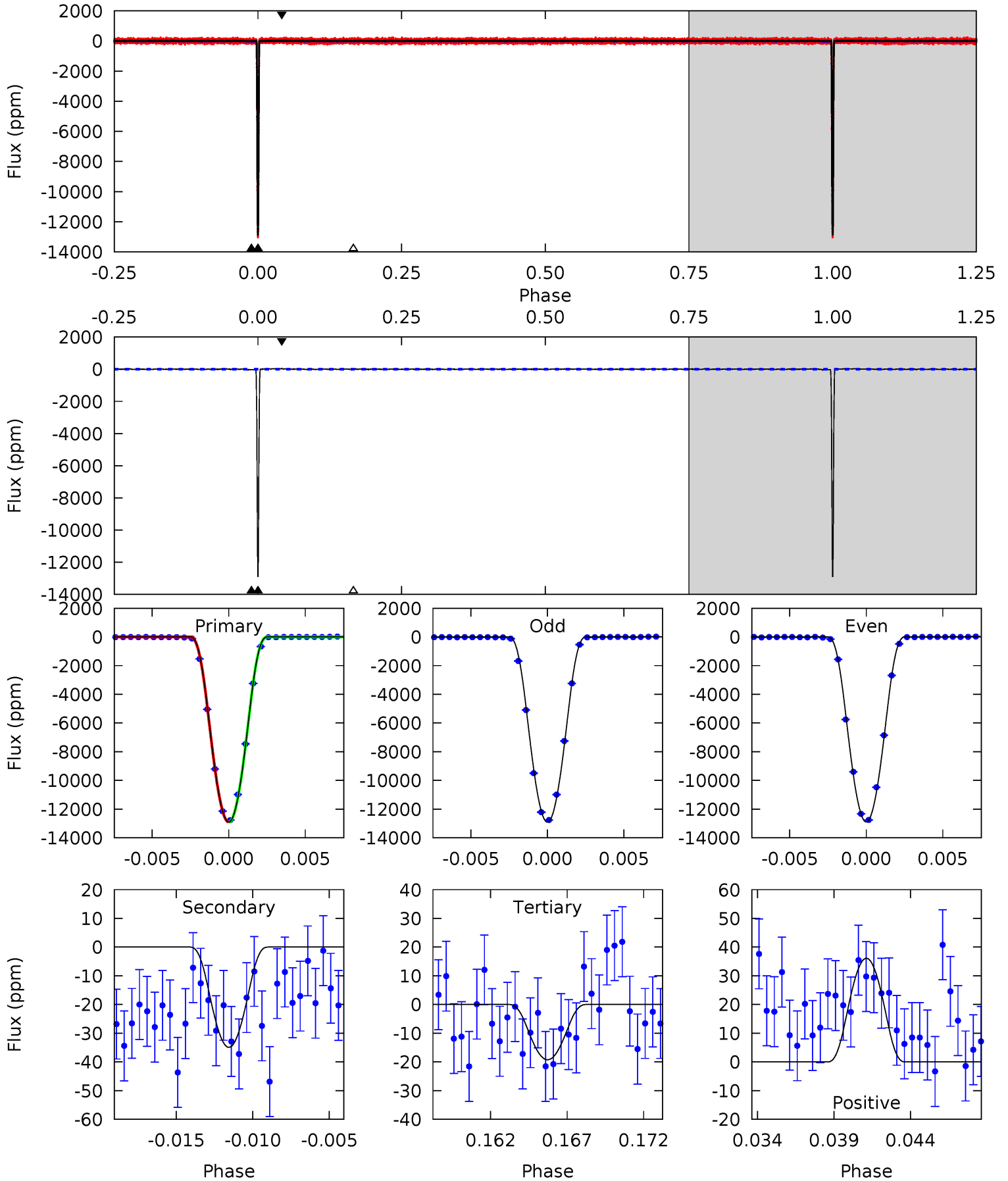
TCE 009786821-01 P= 21.119924 Days  $T_0=150.130811$  (BKJD)



# DV Model-Shift Uniqueness Test

009786821-01, P = 21.120005 Days, E = 129.008419 Days

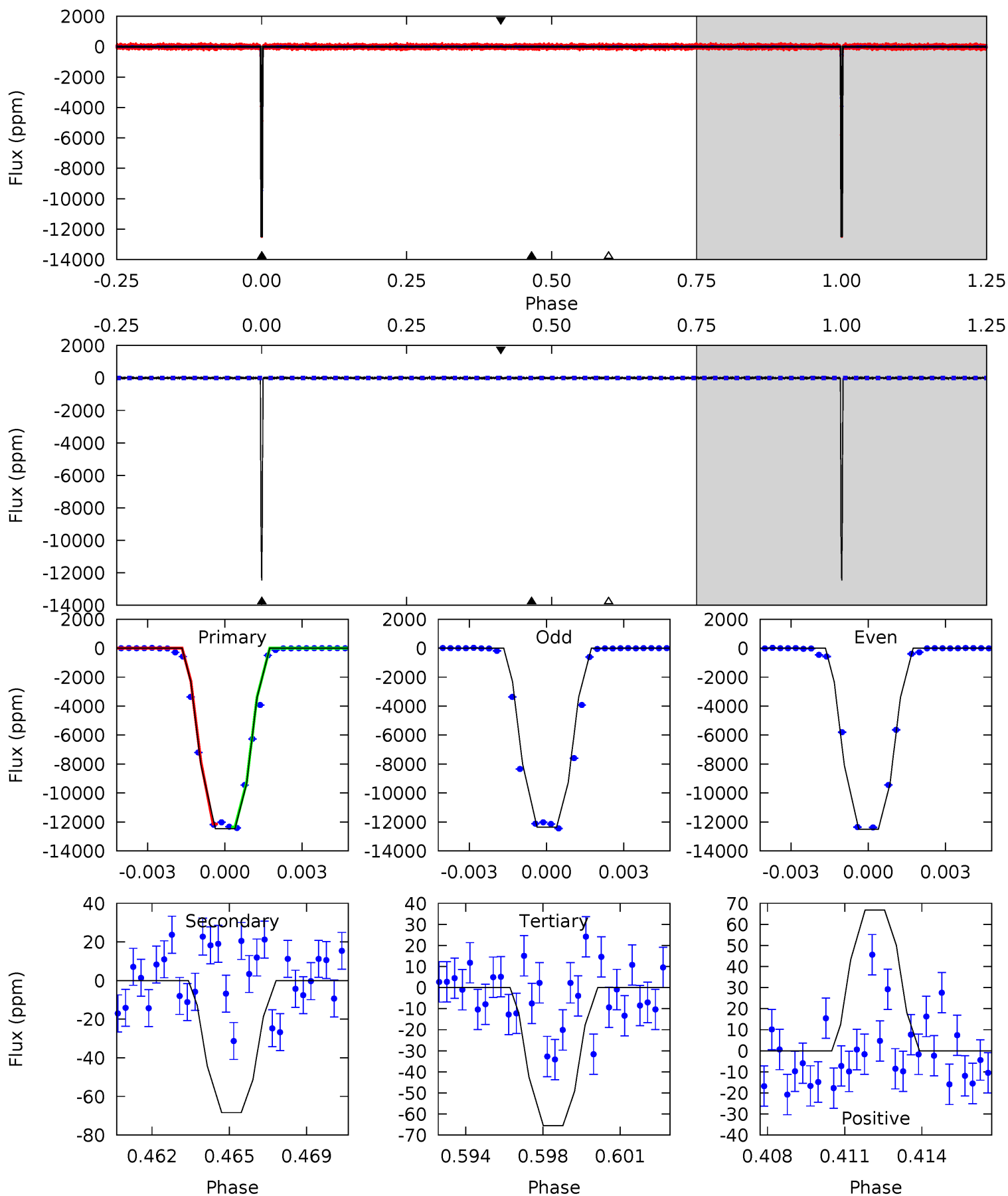
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
3344	9.05	4.99	9.36	5.16	2.81	2.02	3339	3335	4.06	-0.31	1.92	1.00	0.00	0.68



# Alt Model-Shift Uniqueness Test

009786821-01, P = 21.119924 Days, E = 129.010887 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
911.6	5.00	4.80	4.89	5.23	2.93	1.36	906.8	906.7	0.21	0.12	5.15	1.00	0.01	0



### Stellar Parameters For KIC 009786821

	$T_{\text{eff}} (K)$	$\log(g)$	$[\text{Fe}/\text{H}]$	$R (R_{\odot})$	$M (M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$6195^{+199}_{-243}$	$4.069^{+0.306}_{-0.165}$	$-0.200^{+0.250}_{-0.300}$	$1.598^{+0.440}_{-0.538}$	$1.090^{+0.177}_{-0.159}$	$0.377^{+0.865}_{-0.167}$
	+3%/-4%	+8%/-4%	+125%/-150%	+28%/-34%	+16%/-15%	+230%/-44%
Source	PHO54	PHO54	PHO54	DSEP		

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

### Secondary Eclipse Parameters for KIC 009786821-01 / KOI 7230.01

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{\text{max}} (K)$	$T_{\text{obs}} (K)$	$A_{\text{obs}}$
DV	$-35 \pm 4$	$28.87^{+4.82}_{-5.57}$	$1220^{+99}_{-124}$	$1968^{+89}_{-125}$	$0.556^{+0.281}_{-0.153}$
Alt.	$-68 \pm 14$	$19.42^{+3.10}_{-3.35}$	$1211^{+93}_{-105}$	$2474^{+82}_{-94}$	$2.377^{+1.104}_{-0.732}$

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

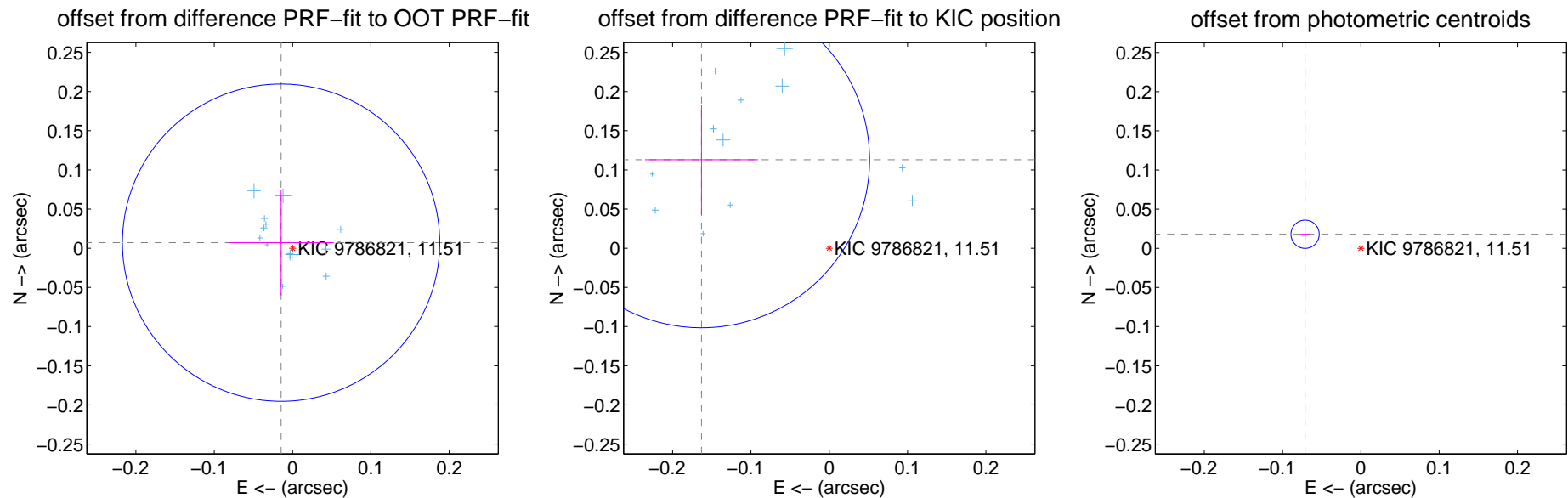
## DV Centroid Data

Supplemental centroid analysis for 009786821-01. **Kepler magnitude: 11.51.** Transit SNR 1642.27

There are 14 quarters with good PRF difference image offsets

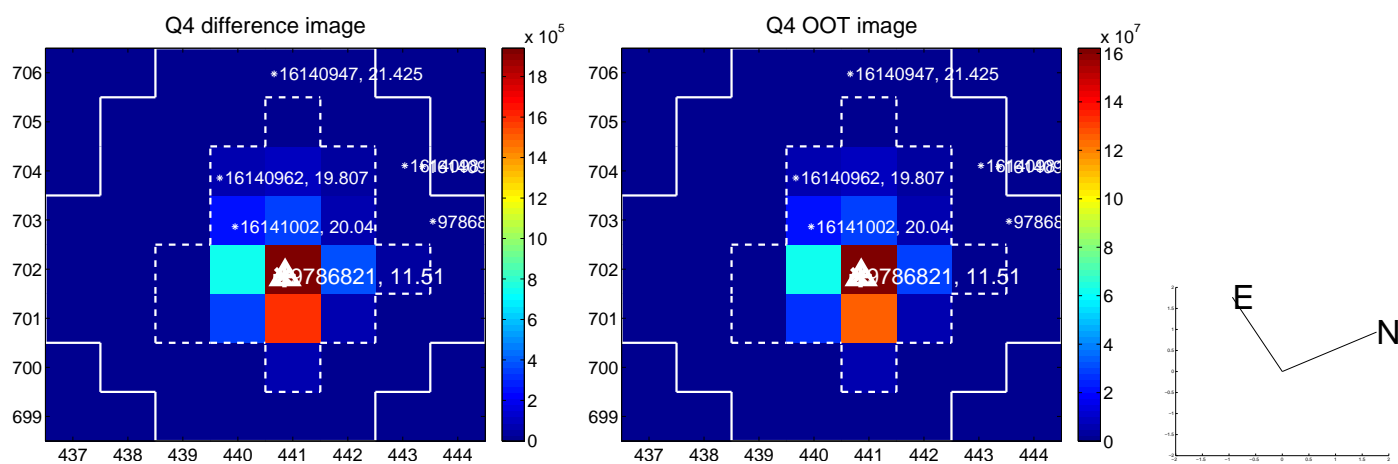
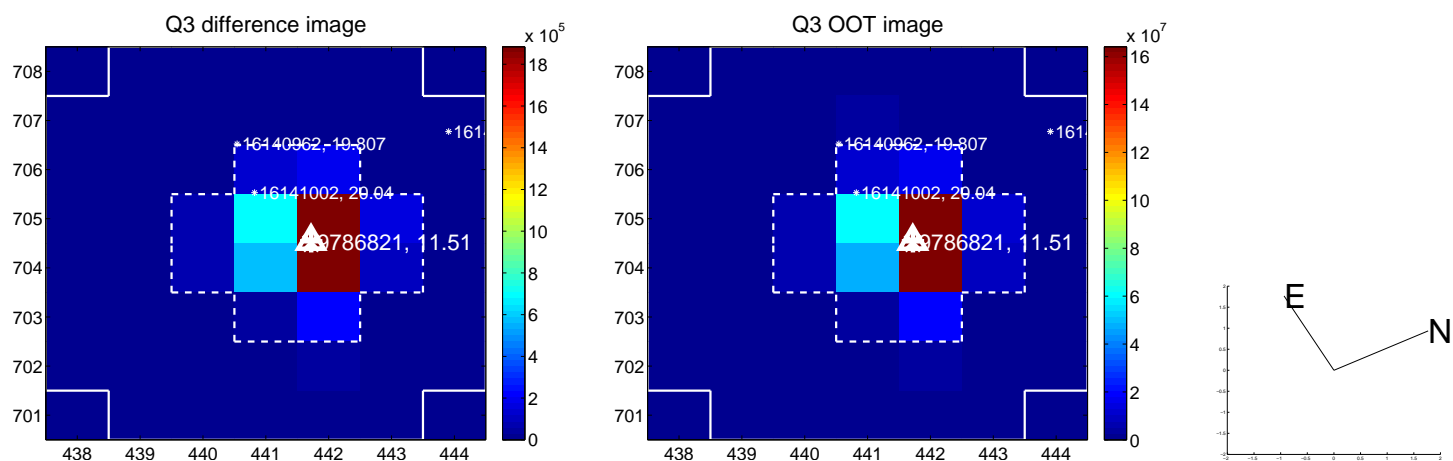
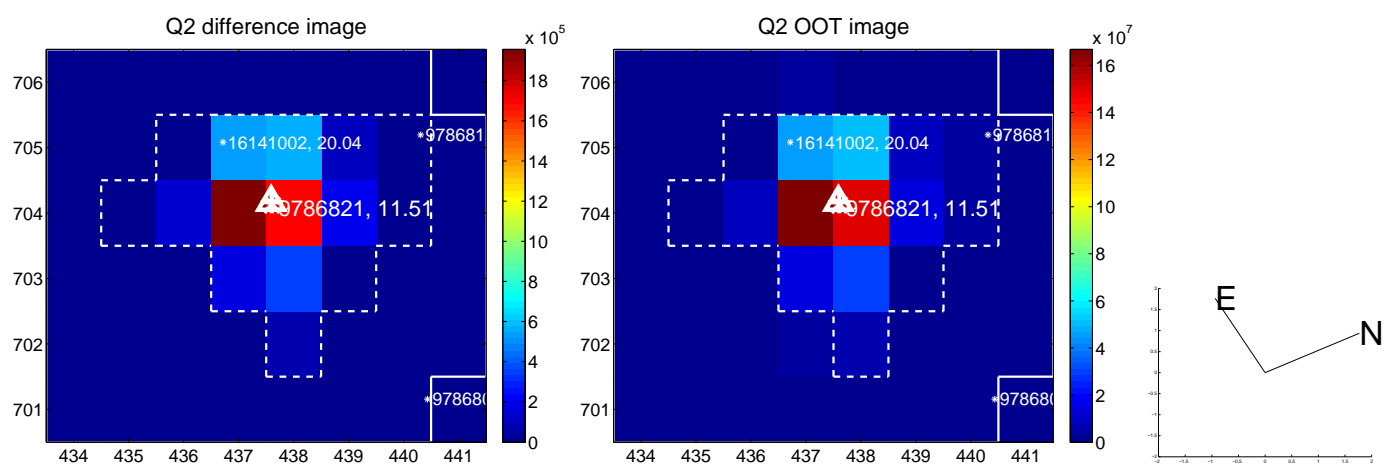
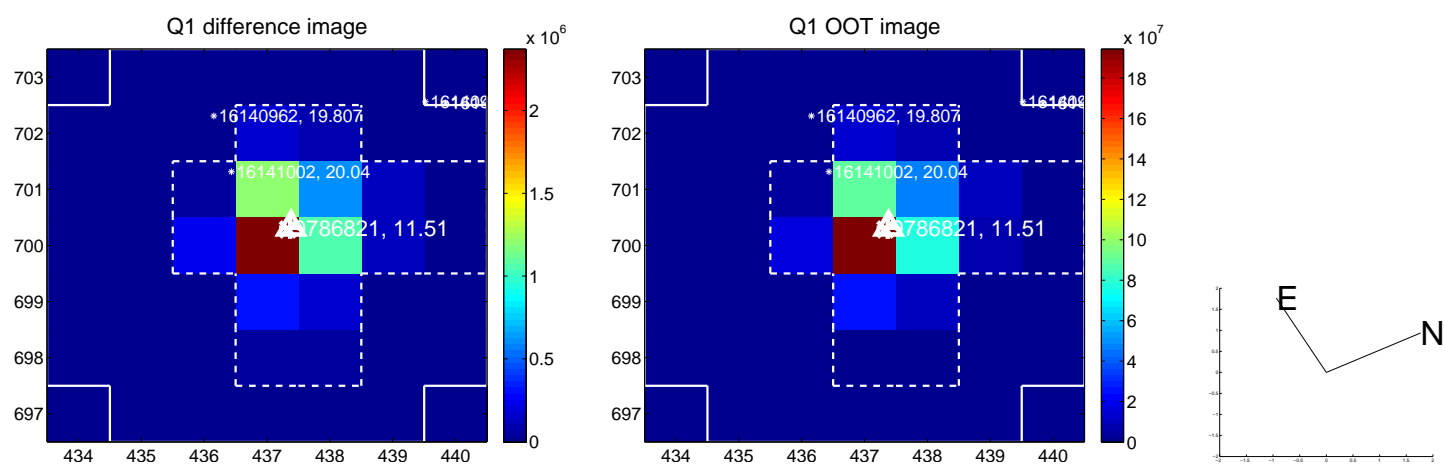
The direct PRF centroid is offset from the target star catalog position by about 0.20 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.016 \pm 0.067$	0.24	$0.015 \pm 0.067$	$0.007 \pm 0.067$
PRF-fit source offset from KIC position	$0.198 \pm 0.071$	2.77	$0.163 \pm 0.072$	$0.113 \pm 0.070$
photometric centroid source offset	$0.07 \pm 0.01$	<b>12.21</b>	$0.07 \pm 0.01$	$0.02 \pm 0.01$

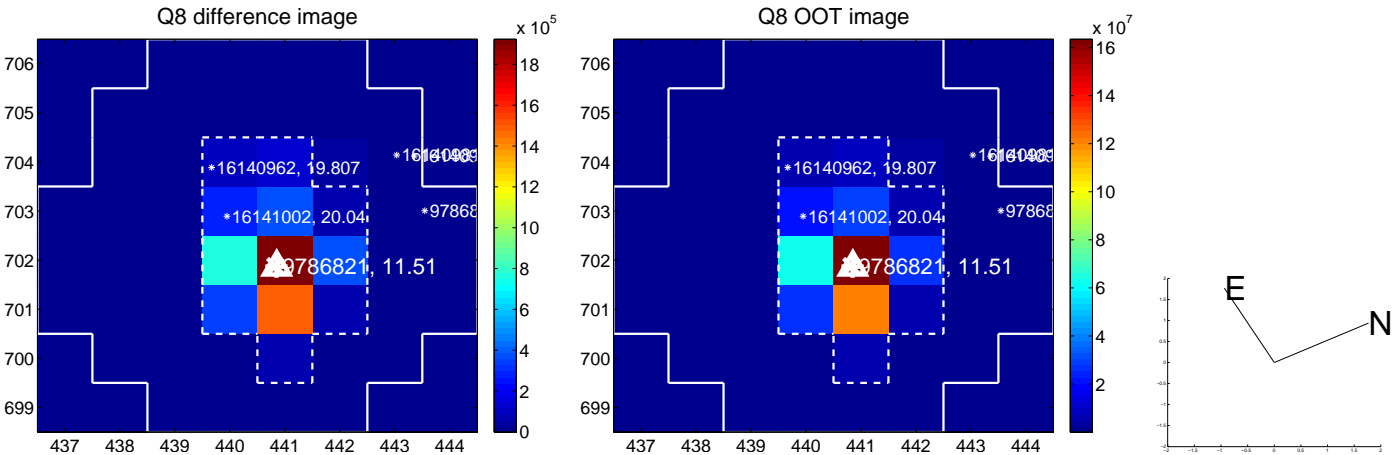
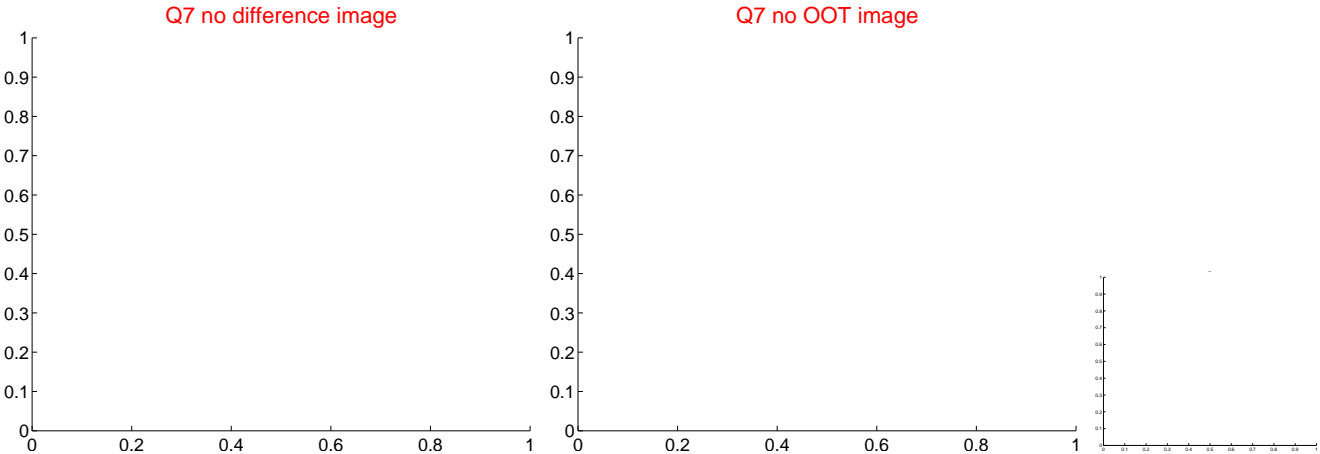
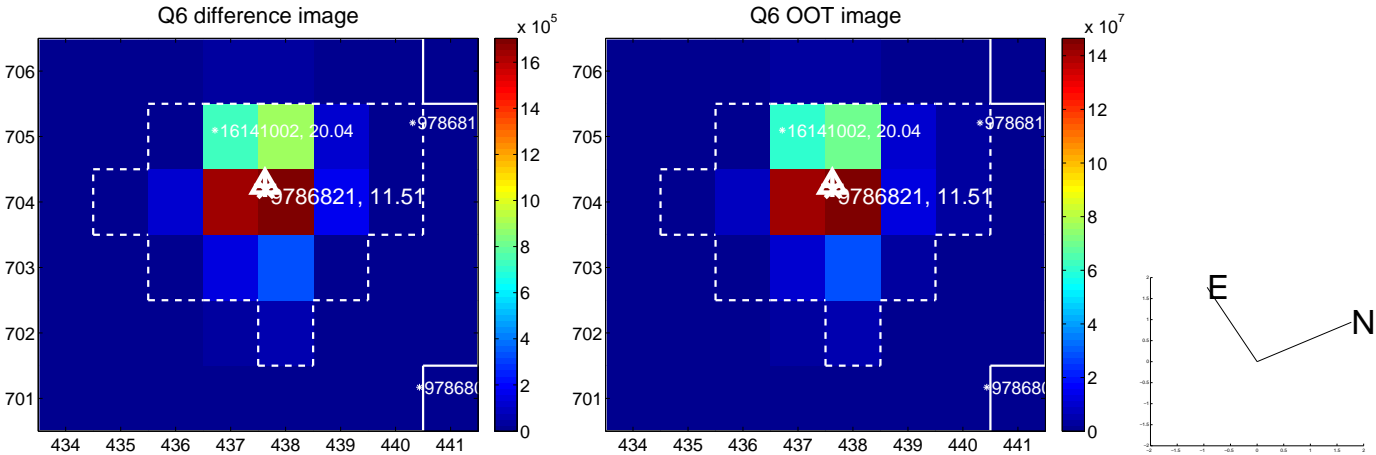
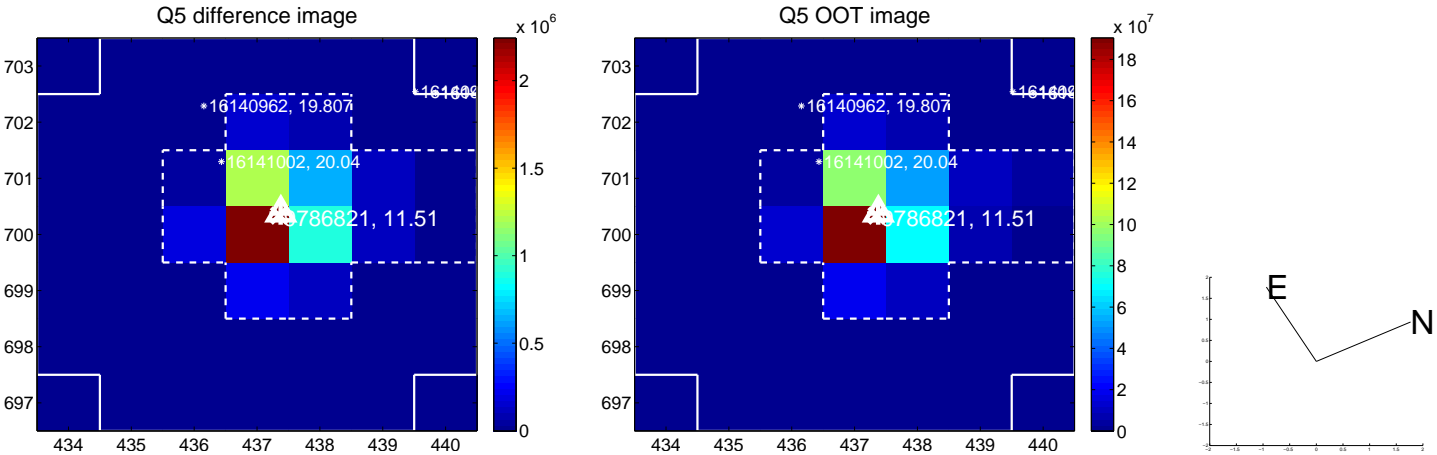


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets;** magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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

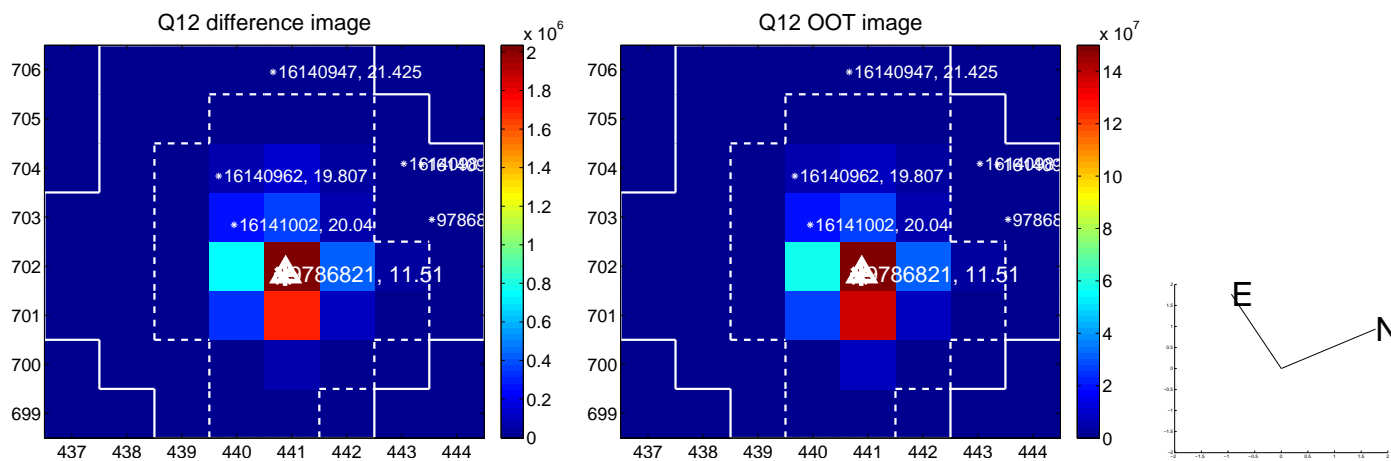
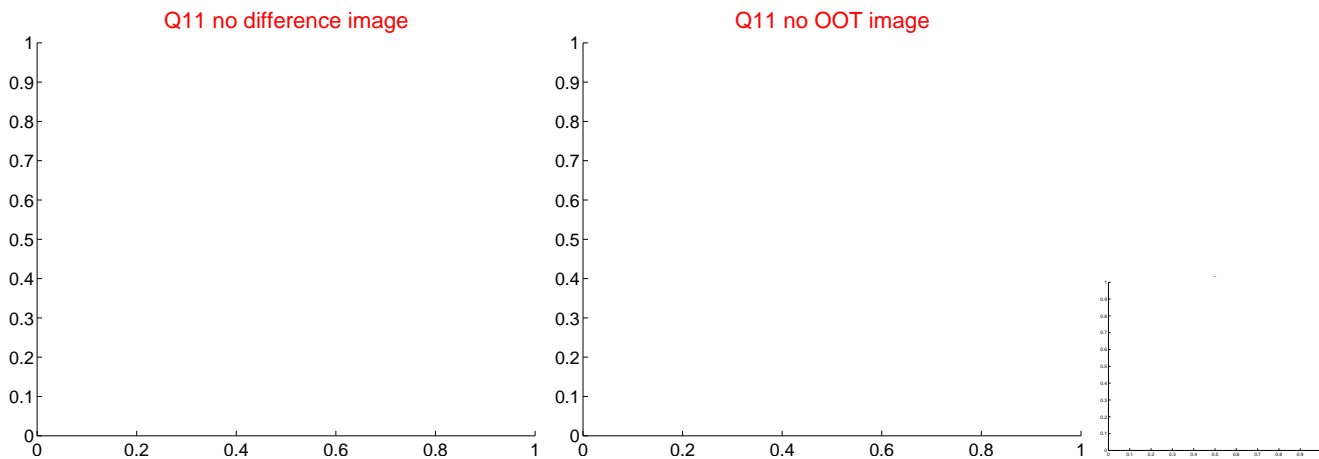
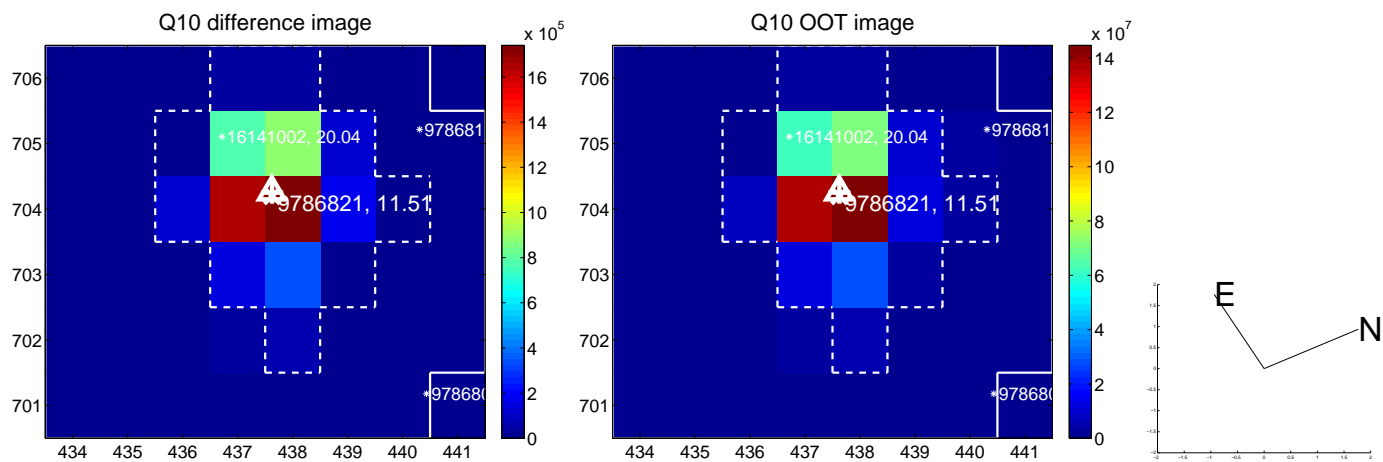
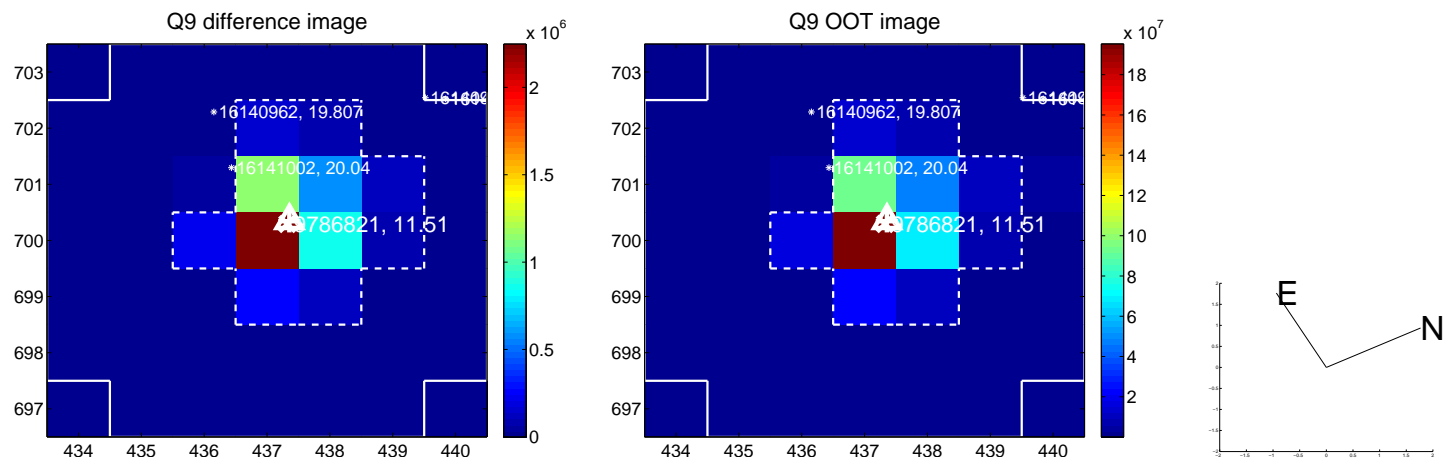


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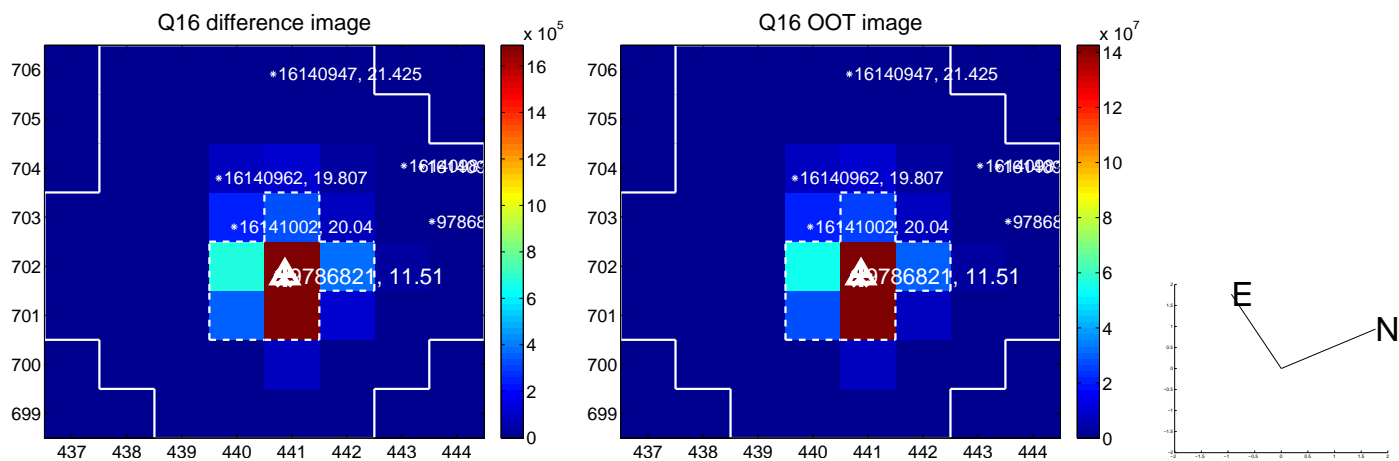
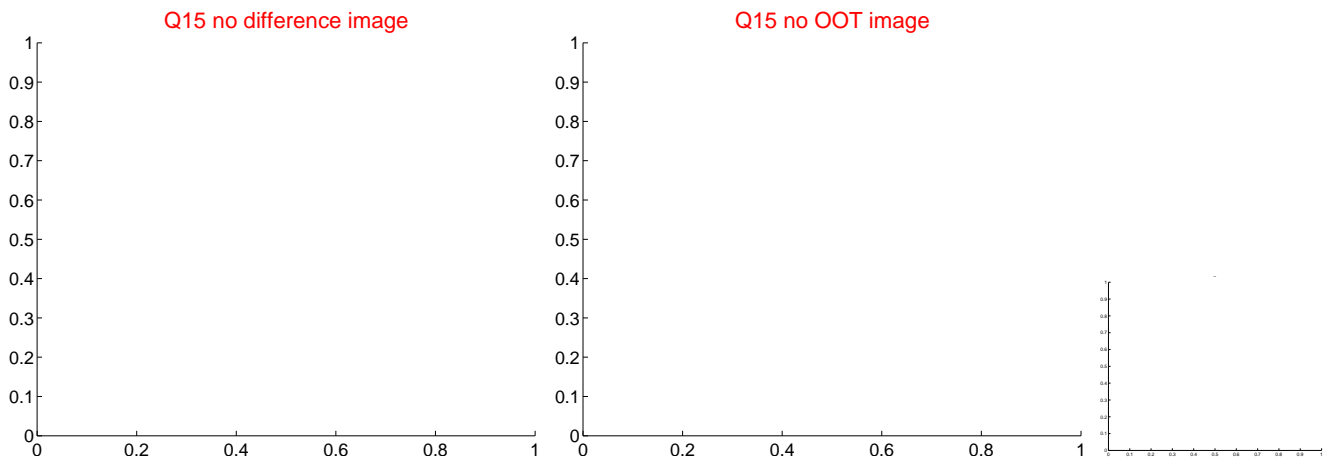
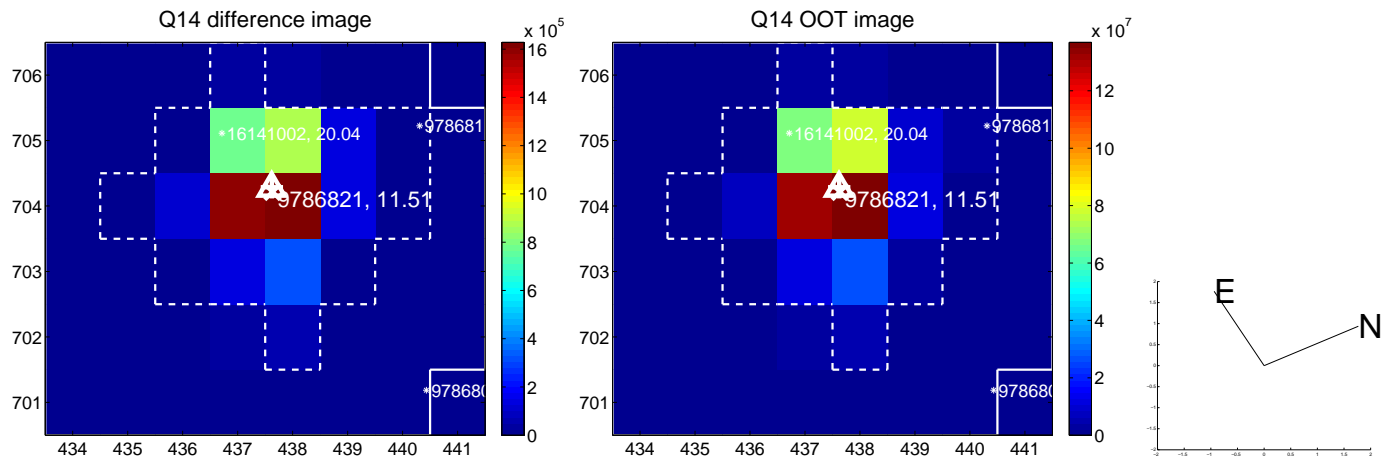
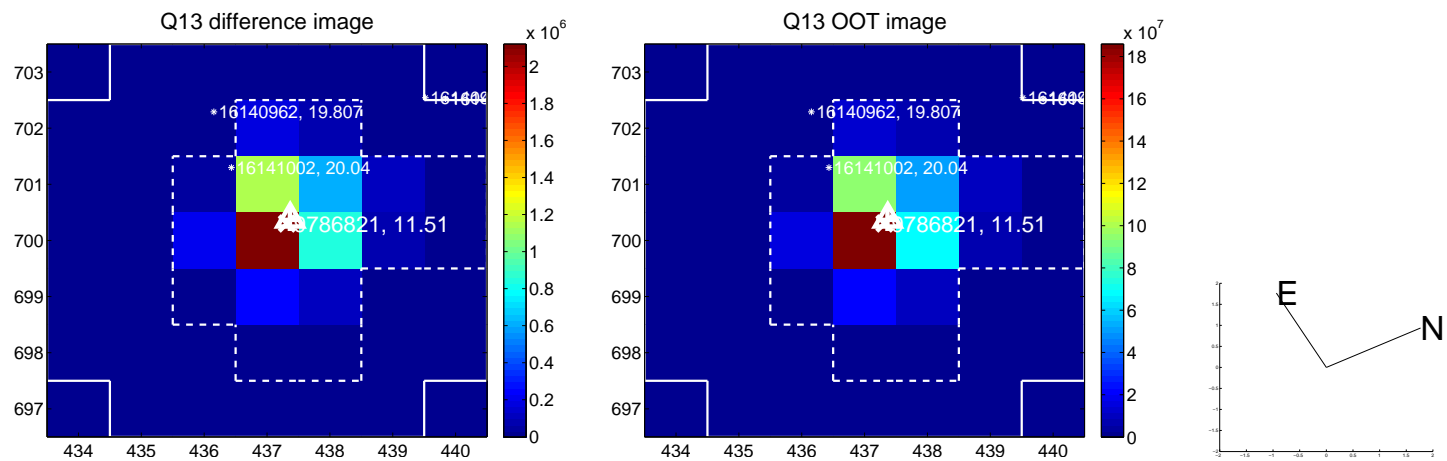




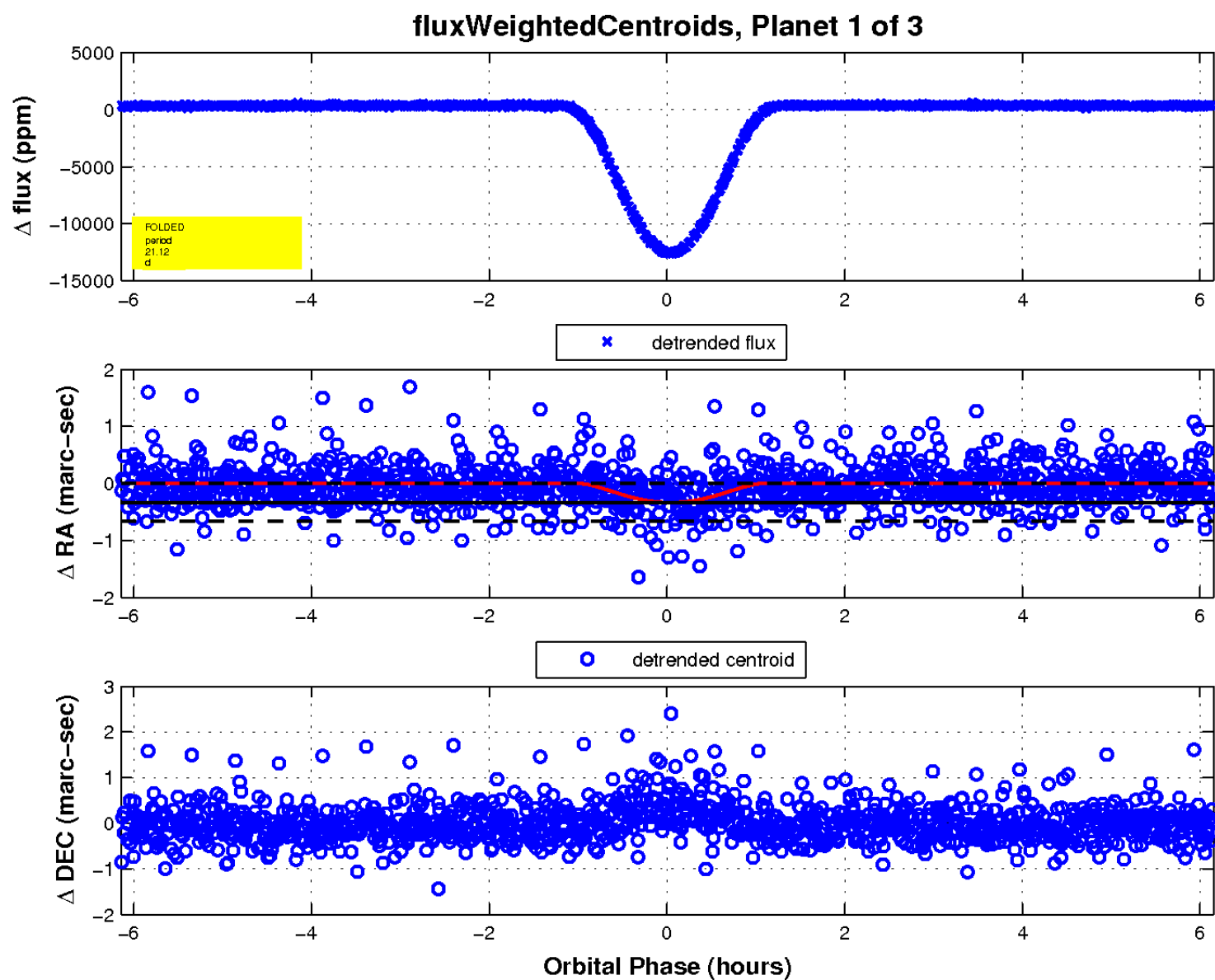
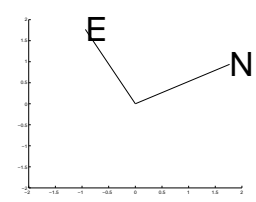
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white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

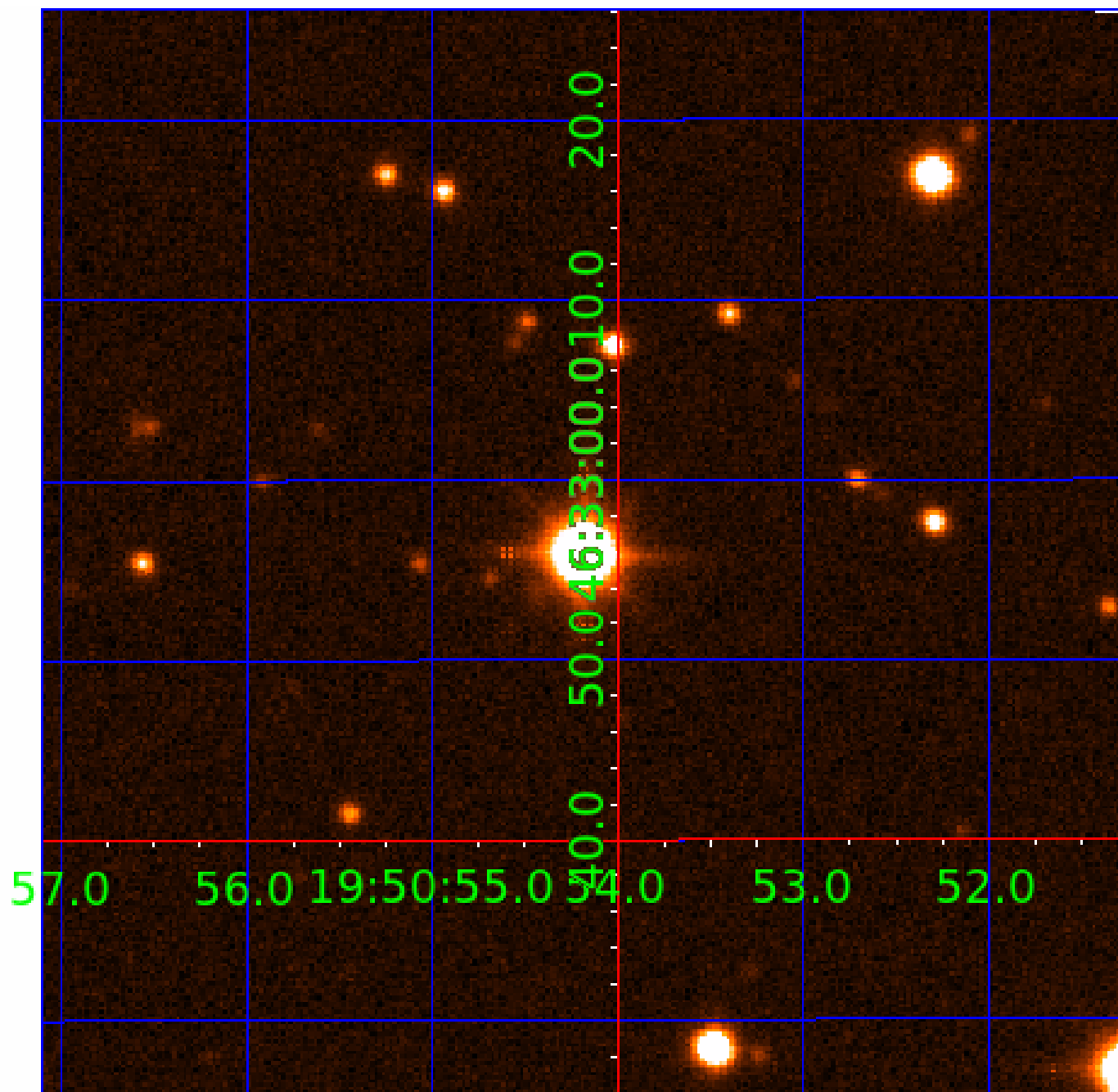


3



UKIRT Image

Declination



# KIC 009786821

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
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009786821-03	OBS	No	21.119584	150.121749	403.4	36.937	18.0	24.1	1.60	6195	6.29	142.08

## Robovetter Results

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009786821-03	OBS	FP	0.00	1	0	0	0	LPP_DV—RESIDUAL_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.

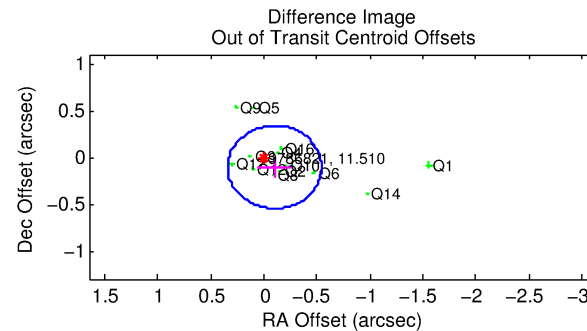
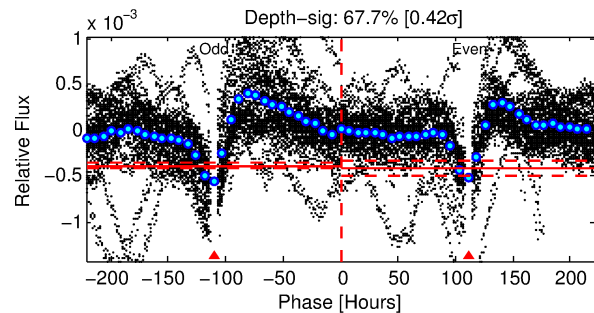
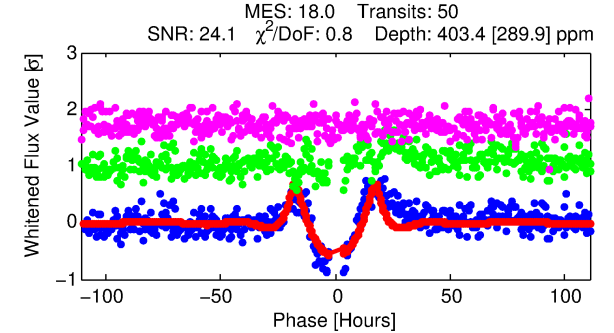
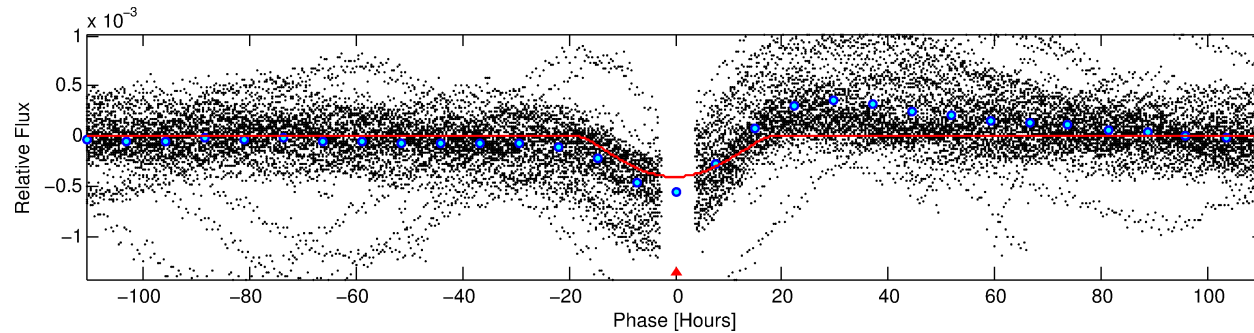
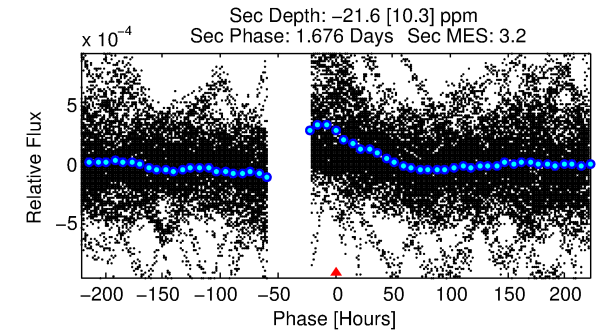
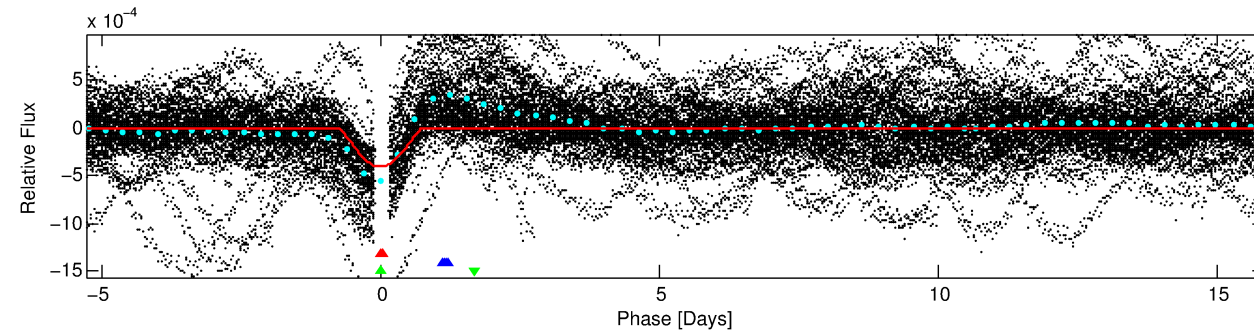
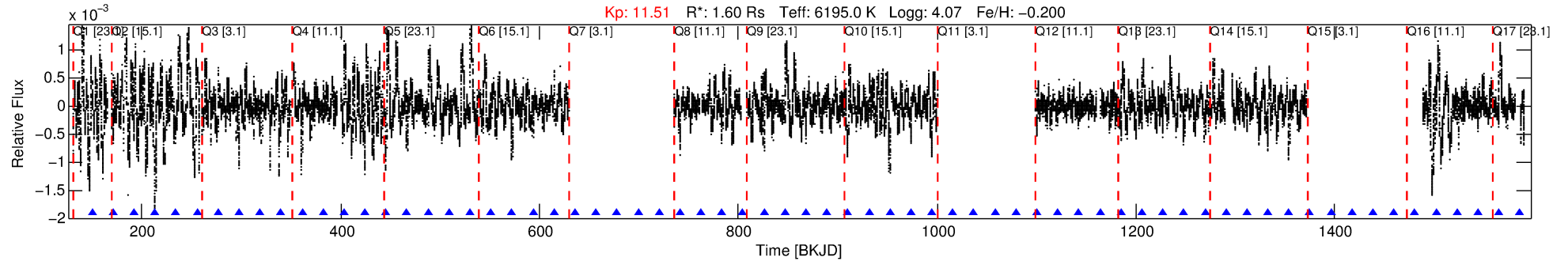
## Ephemeris Match Information For 009786821-03

No Significant Match Found

# DV One-Page Summary

KIC: 9786821 Candidate: 3 of 3 Period: 21.120 d

KOI: K07230 Corr: No Ephemeris Match



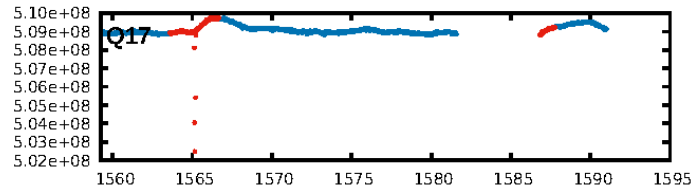
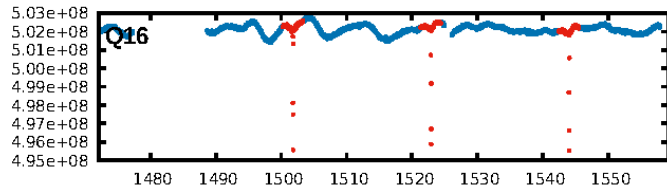
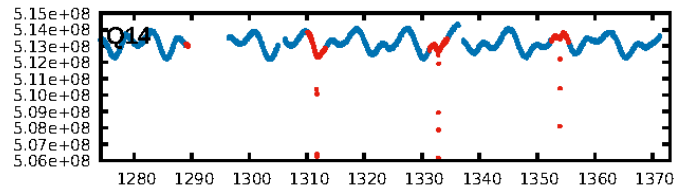
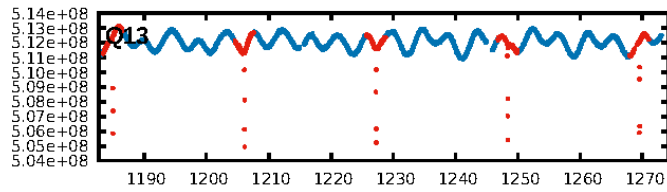
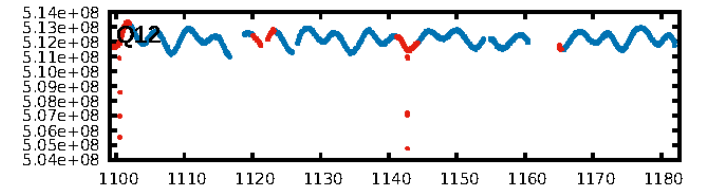
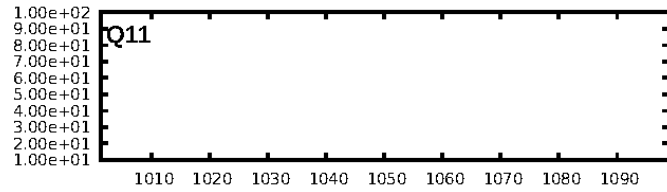
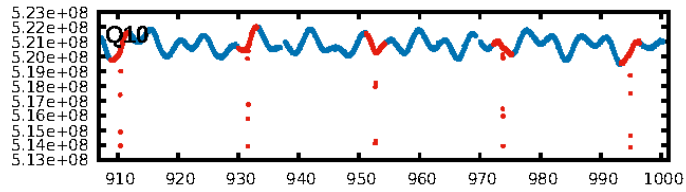
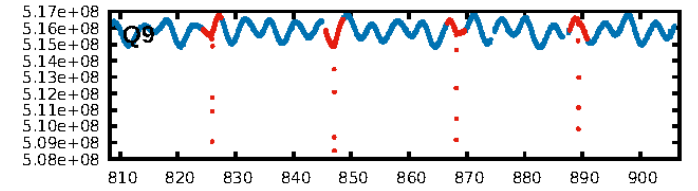
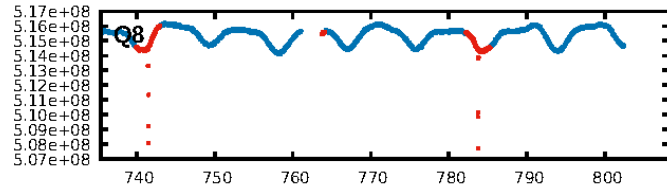
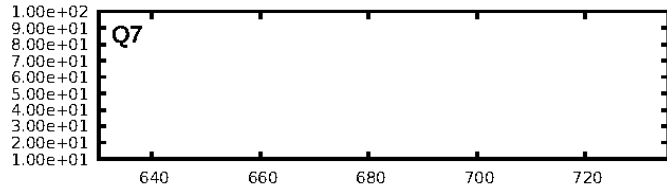
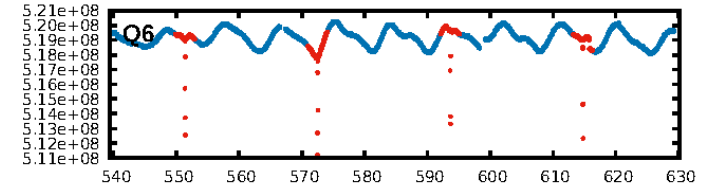
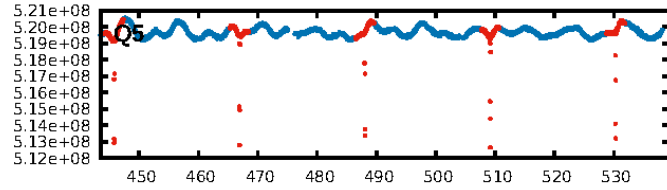
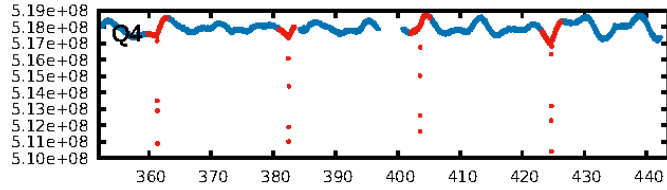
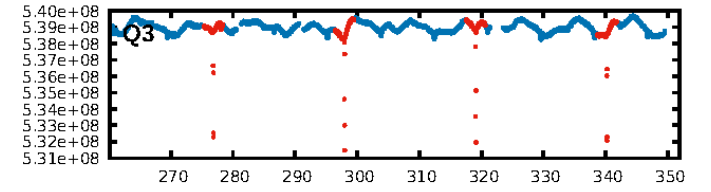
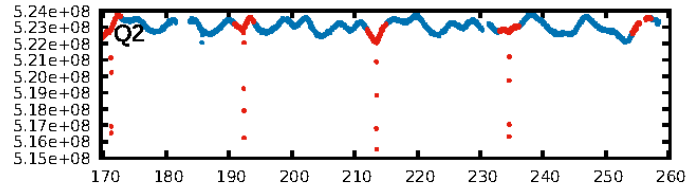
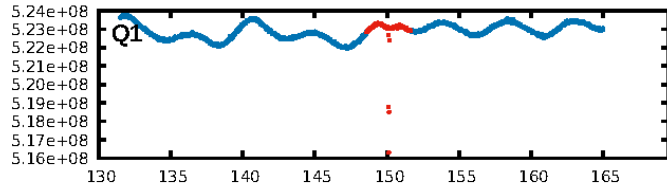
## DV Fit Results:

Period = 21.11958 [0.00034] d  
Epoch = 150.1217 [0.0123] BKJD  
Rp/R\* = 0.0360 [0.0110]  
a/R\* = 1.56 [0.05]  
b = 1.00 [0.03]  
Seff = 142.08 [77.25]  
Teff = 880 [120] K  
Rp = 6.29 [2.85] Re  
a = 0.1540 [0.0500] AU  
Ag = N/A  
Teffp = N/A

## DV Diagnostic Results:

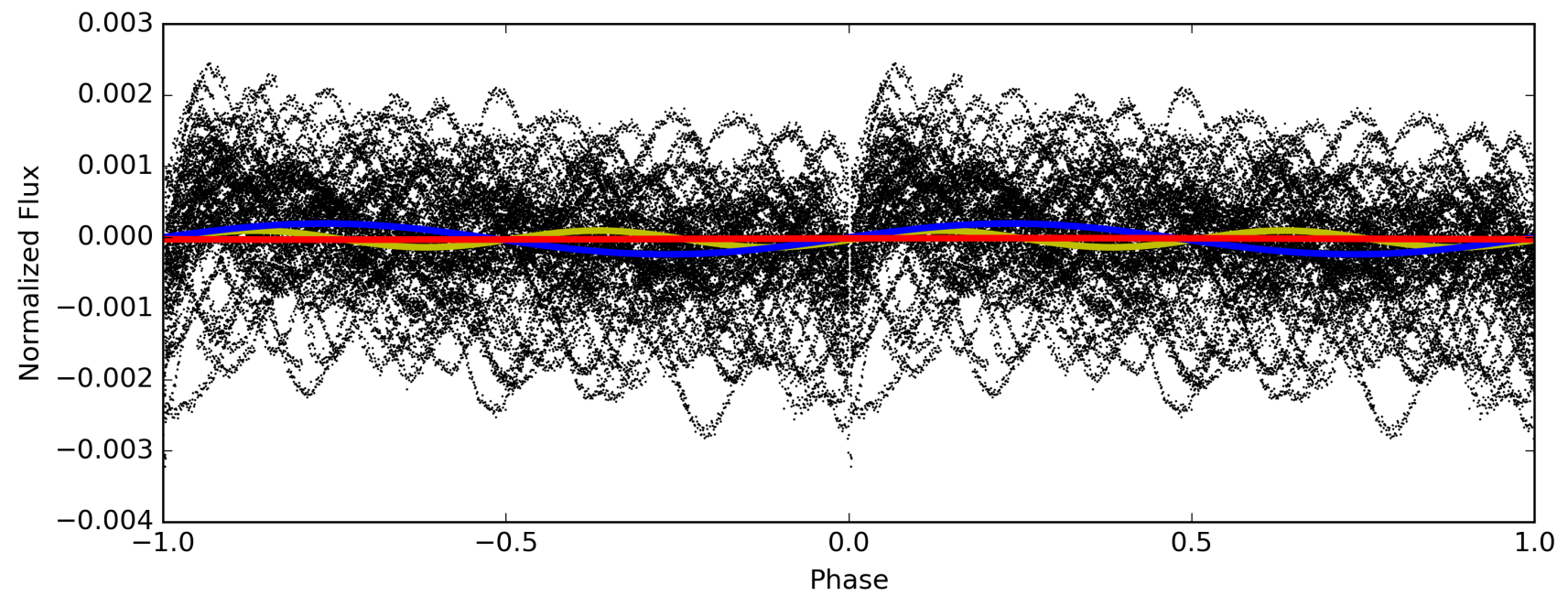
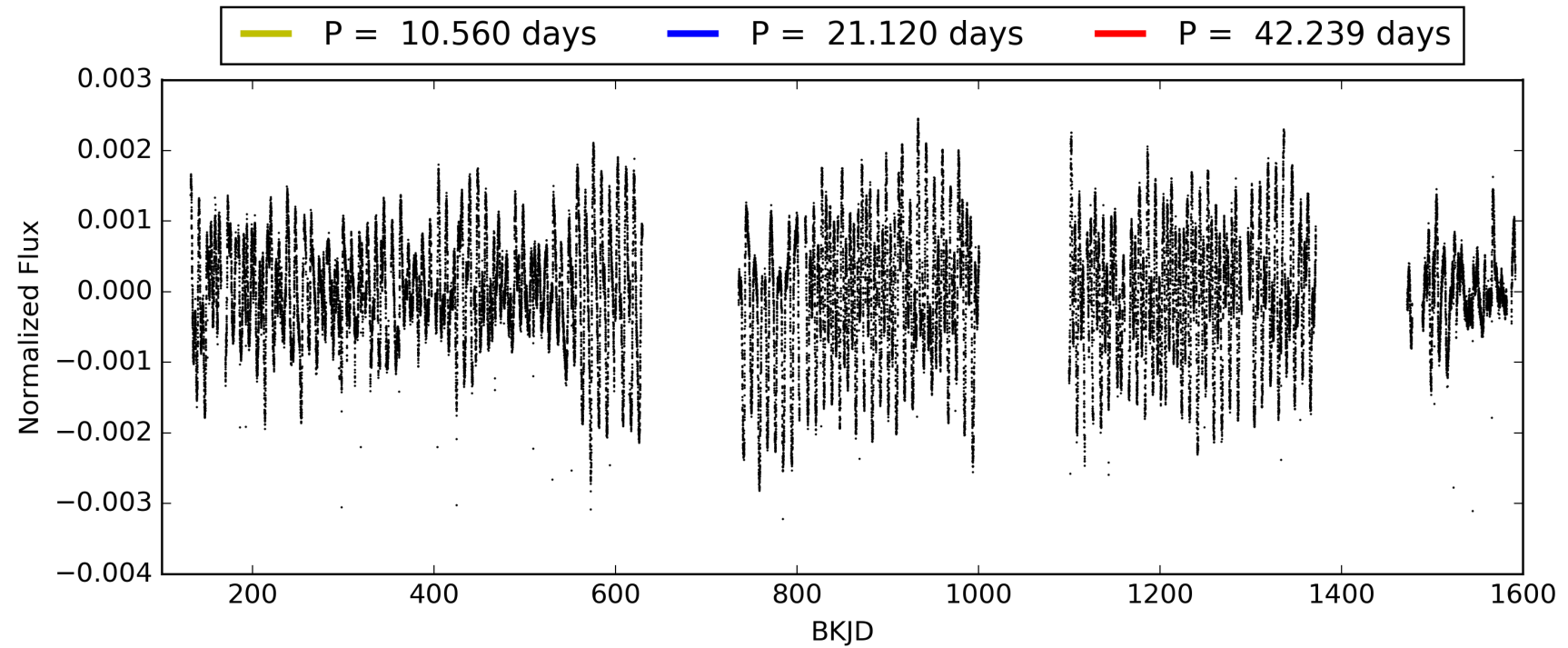
ShortPeriod-sig: N/A  
LongPeriod-sig: 0.0% [0.00σ]  
ModelChiSquare2-sig: 98.7%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 1.26e-44  
RollingBand-fgt: 1.00 [47/47]  
GhostDiagnostic-chr: 1.253  
Centroid-sig: N/A  
Centroid-so: 0.255 arcsec [2.38σ]  
OotOffset-rm: 0.145 arcsec [0.98σ]  
KicOffset-rm: 0.030 arcsec [0.22σ]  
OotOffset-st: 4/1/4/4 [13]  
KicOffset-st: 4/1/4/4 [13]  
DiffImageQuality-fgm: 1.00 [13/13]  
DiffImageOverlap-fno: 0.00 [0/13]

# TCE 009786821-03, PDC Light Curves





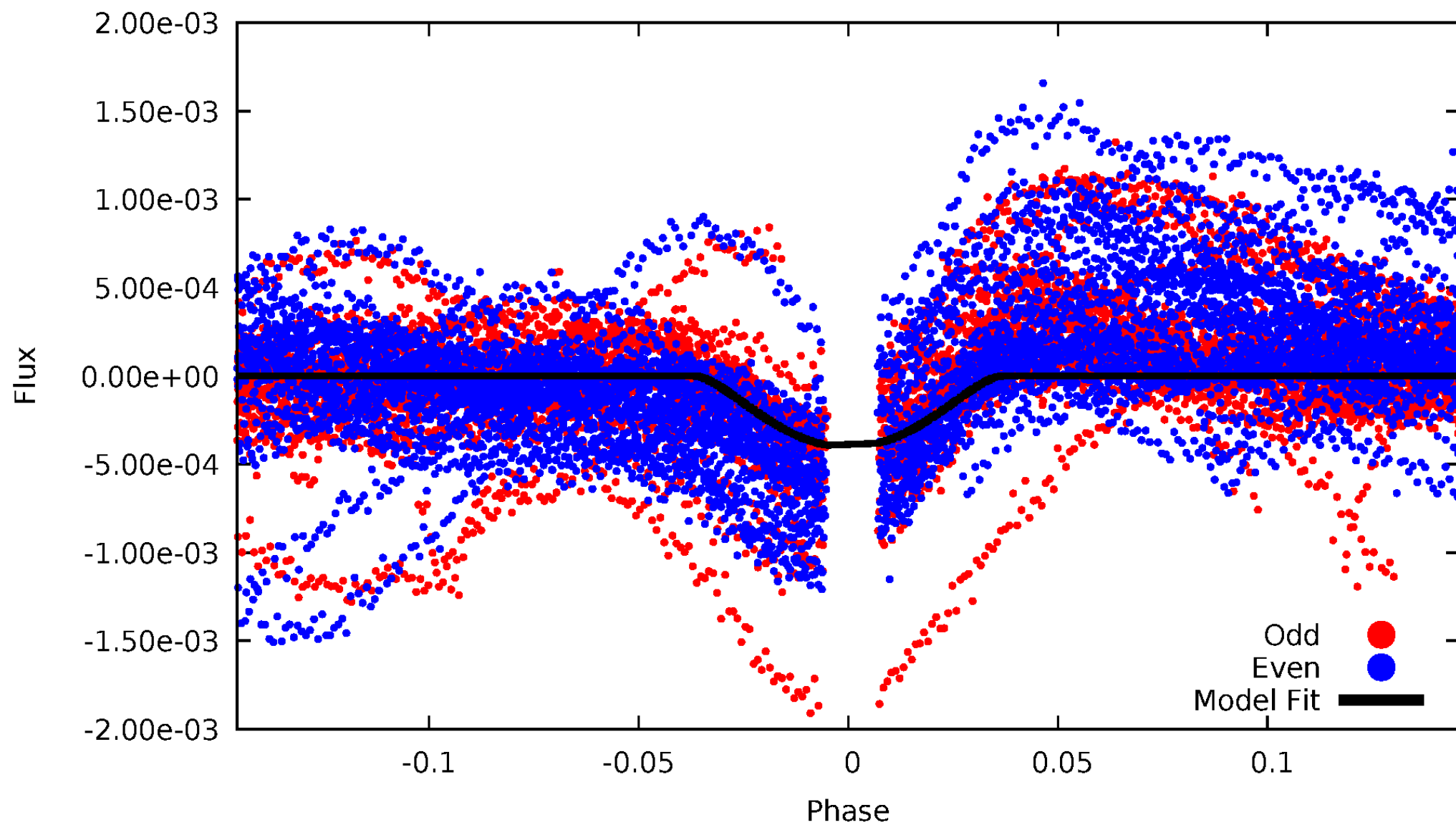
TCE 009786821-03





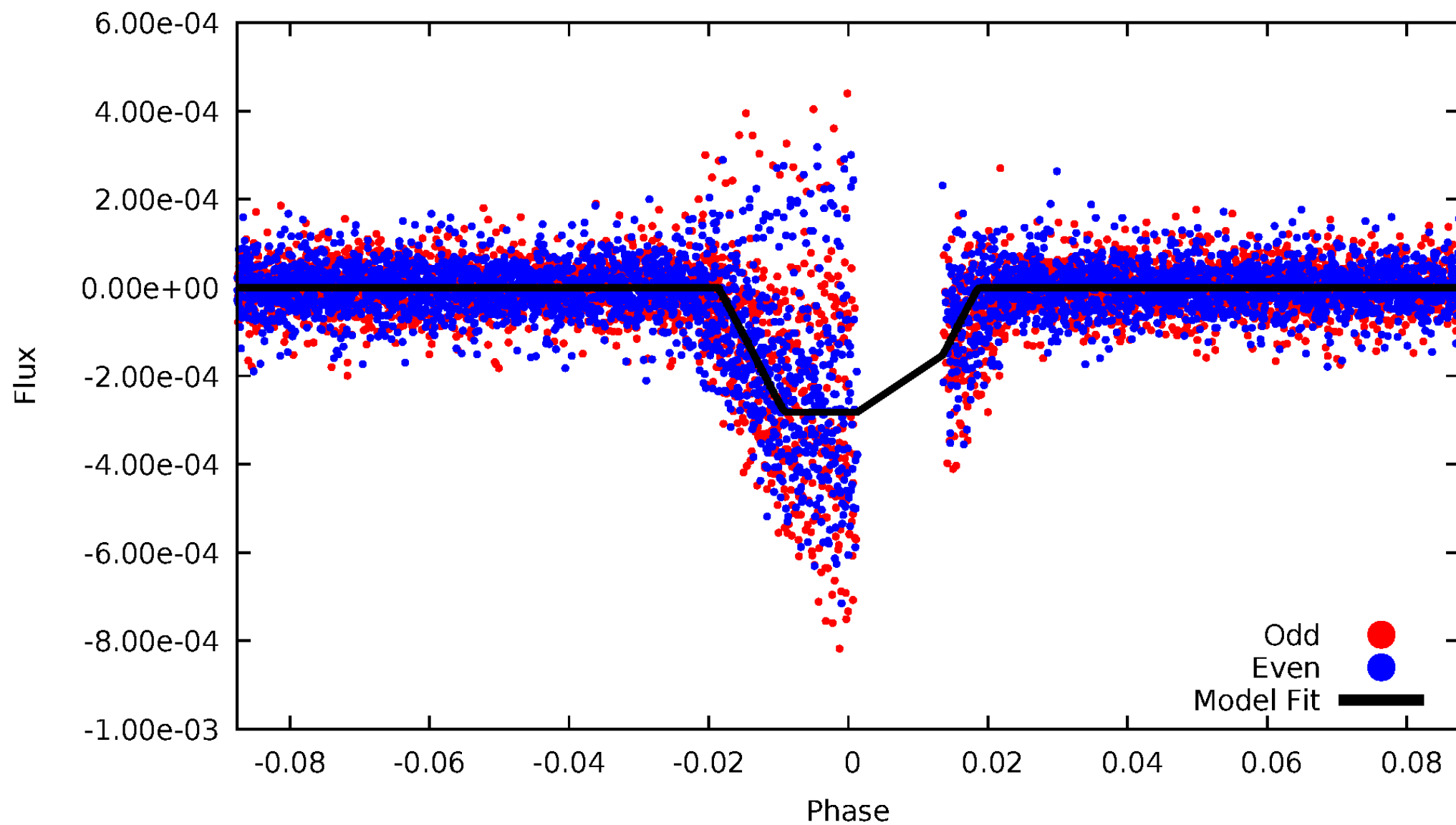
# DV Odd/Even

TCE 009786821-03

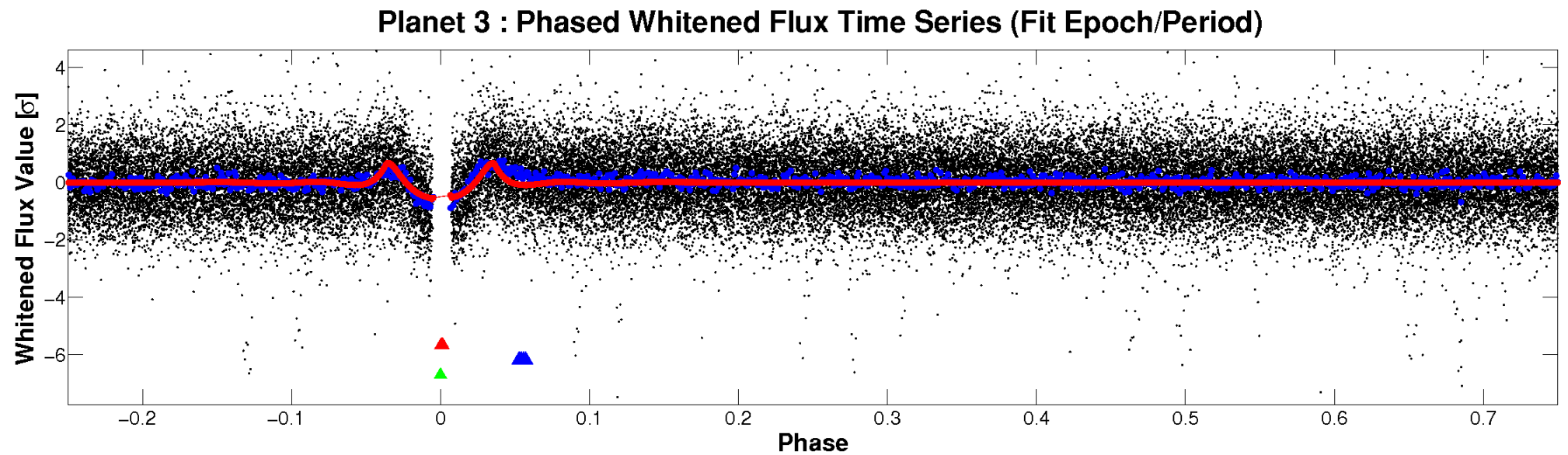
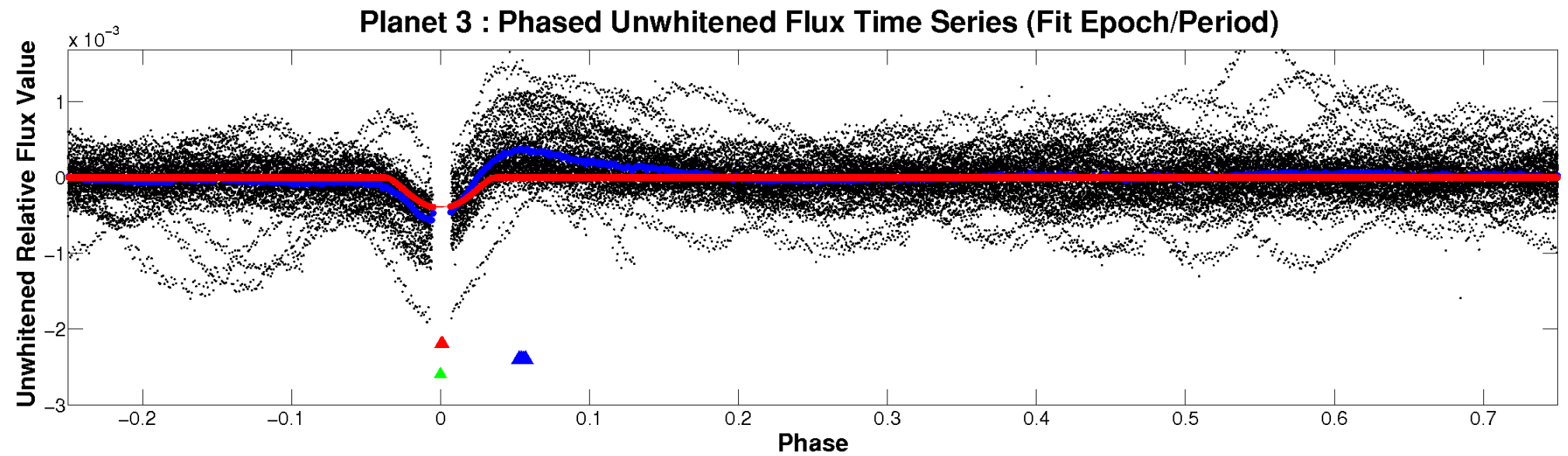


# ALT Odd/Even

TCE 009786821-03

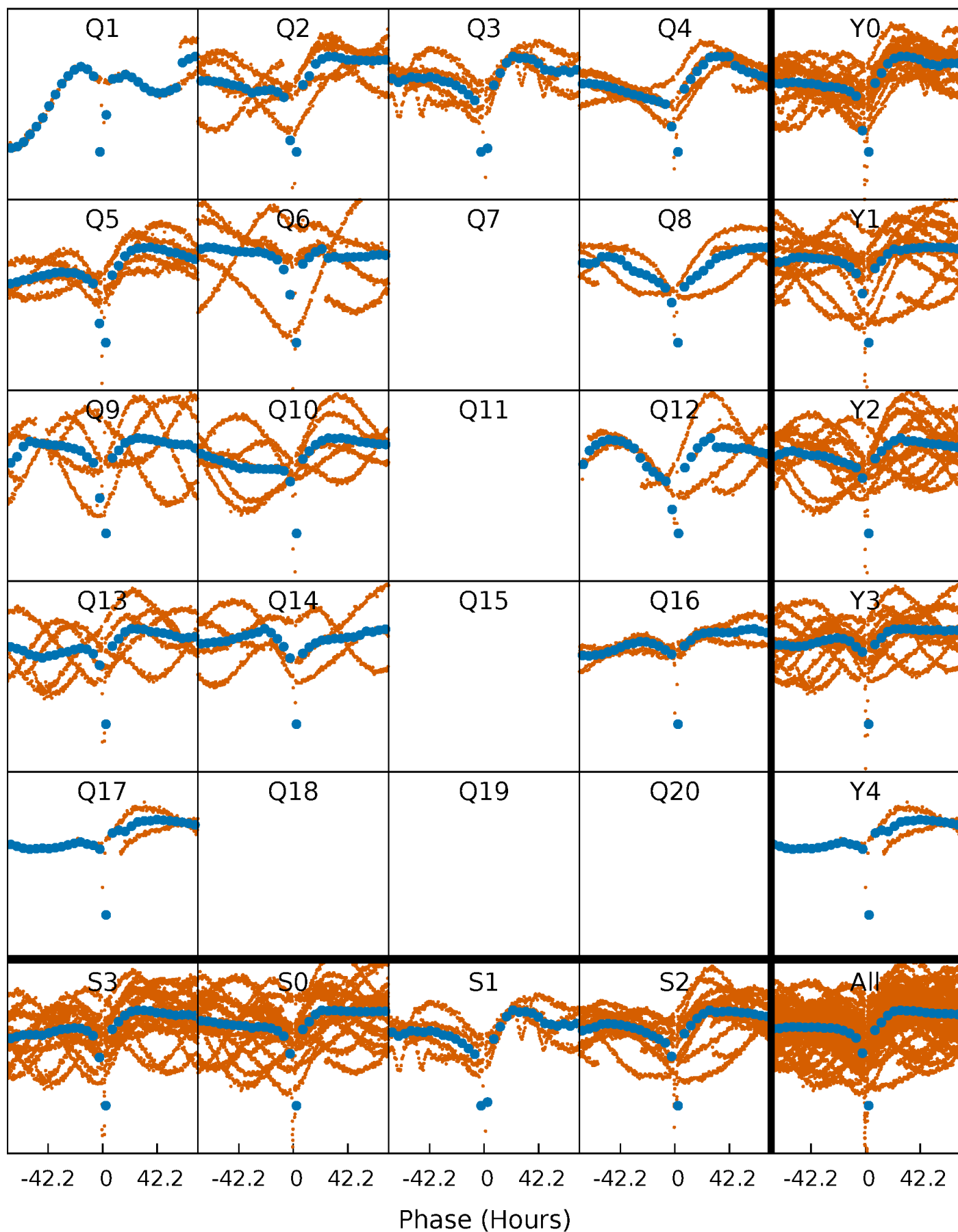


# Non-Whitened Vs. Whitened Light Curve



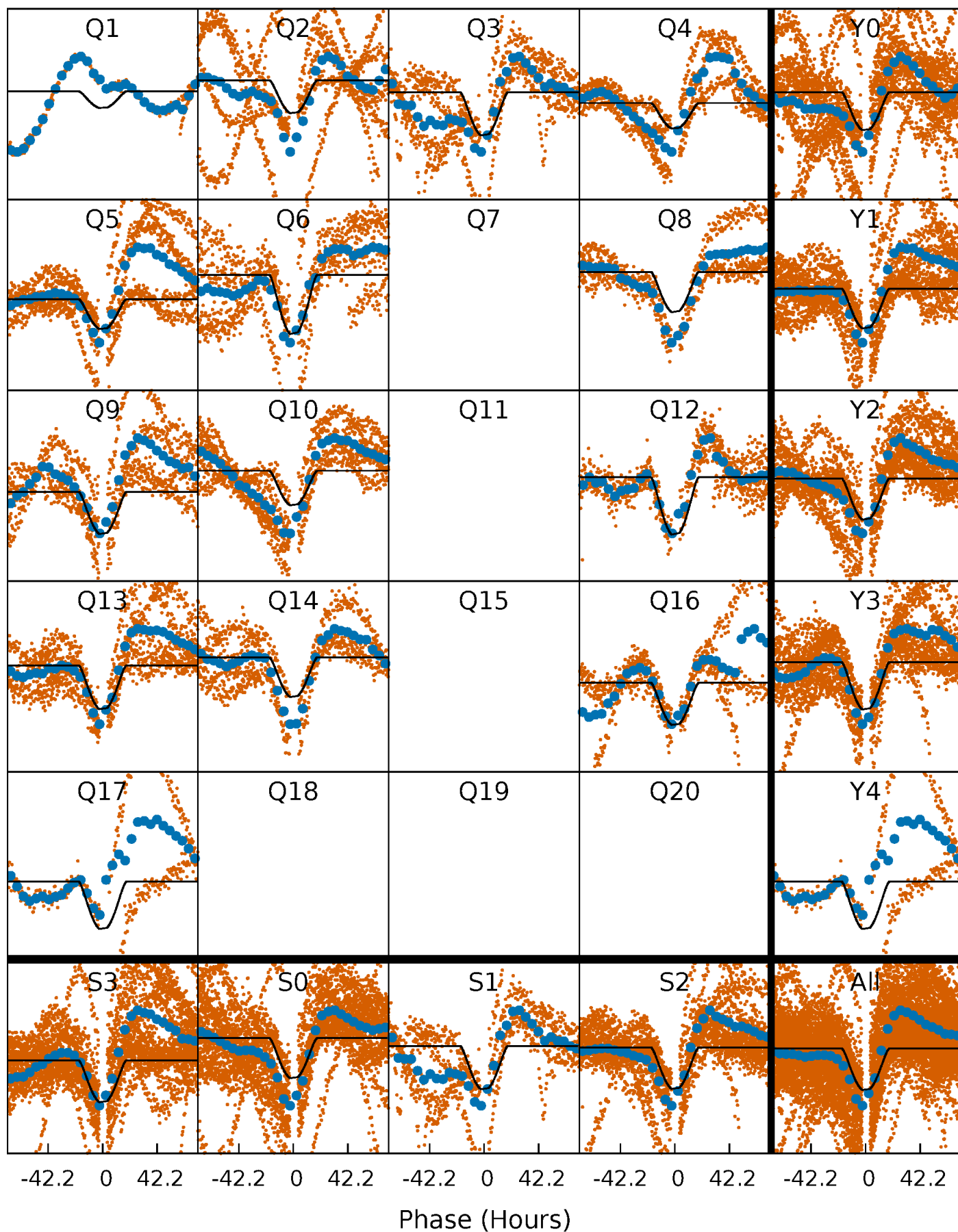
# PDC Quarter-Phased Transit Curves

TCE 009786821-03 P= 21.119584 Days  $T_0=150.121748$  (BKJD)



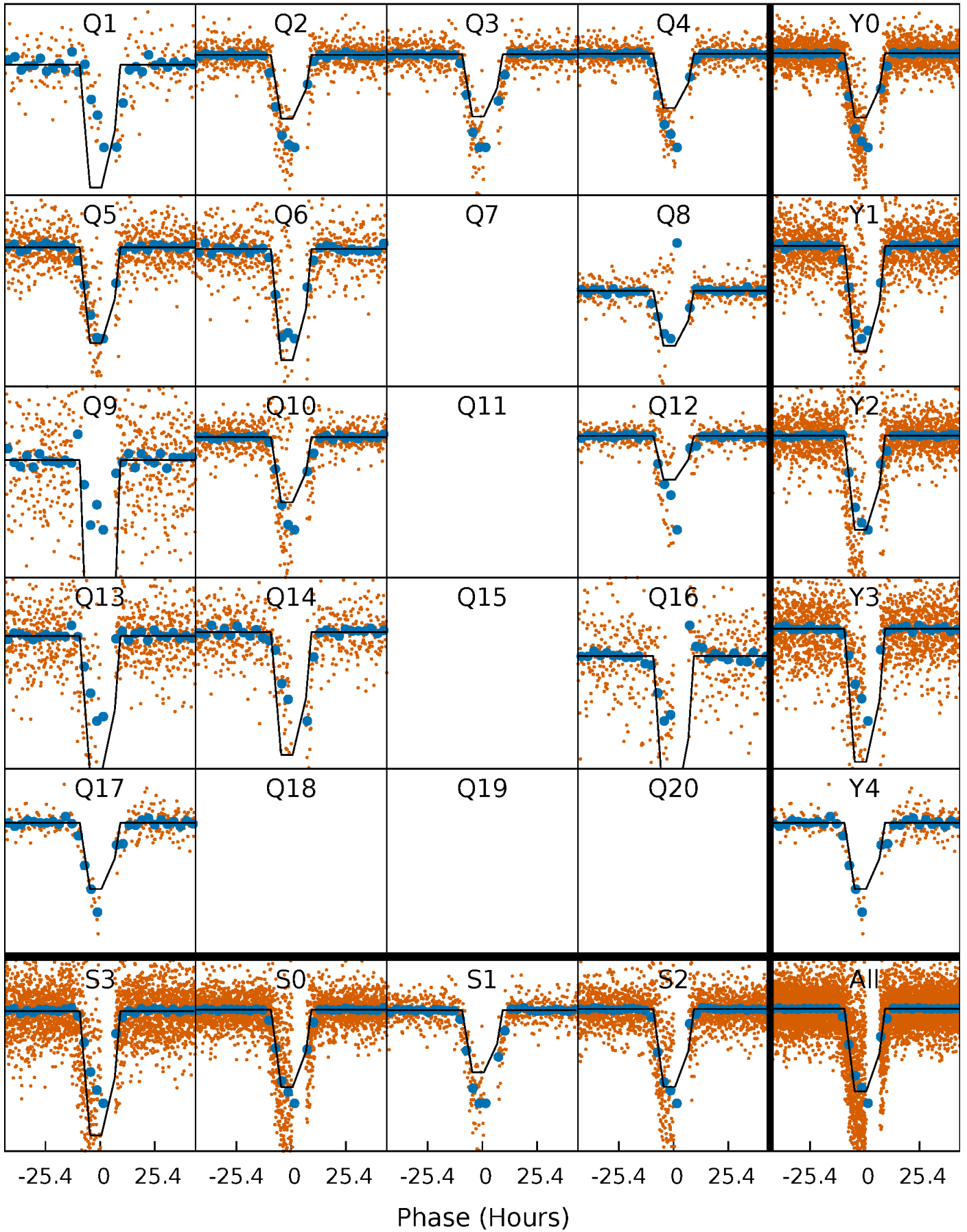
# DV Quarter-Phased Transit Curves

TCE 009786821-03 P= 21.119584 Days  $T_0=150.121748$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

TCE 009786821-03 P= 21.120410 Days  $T_0=149.958799$  (BKJD)

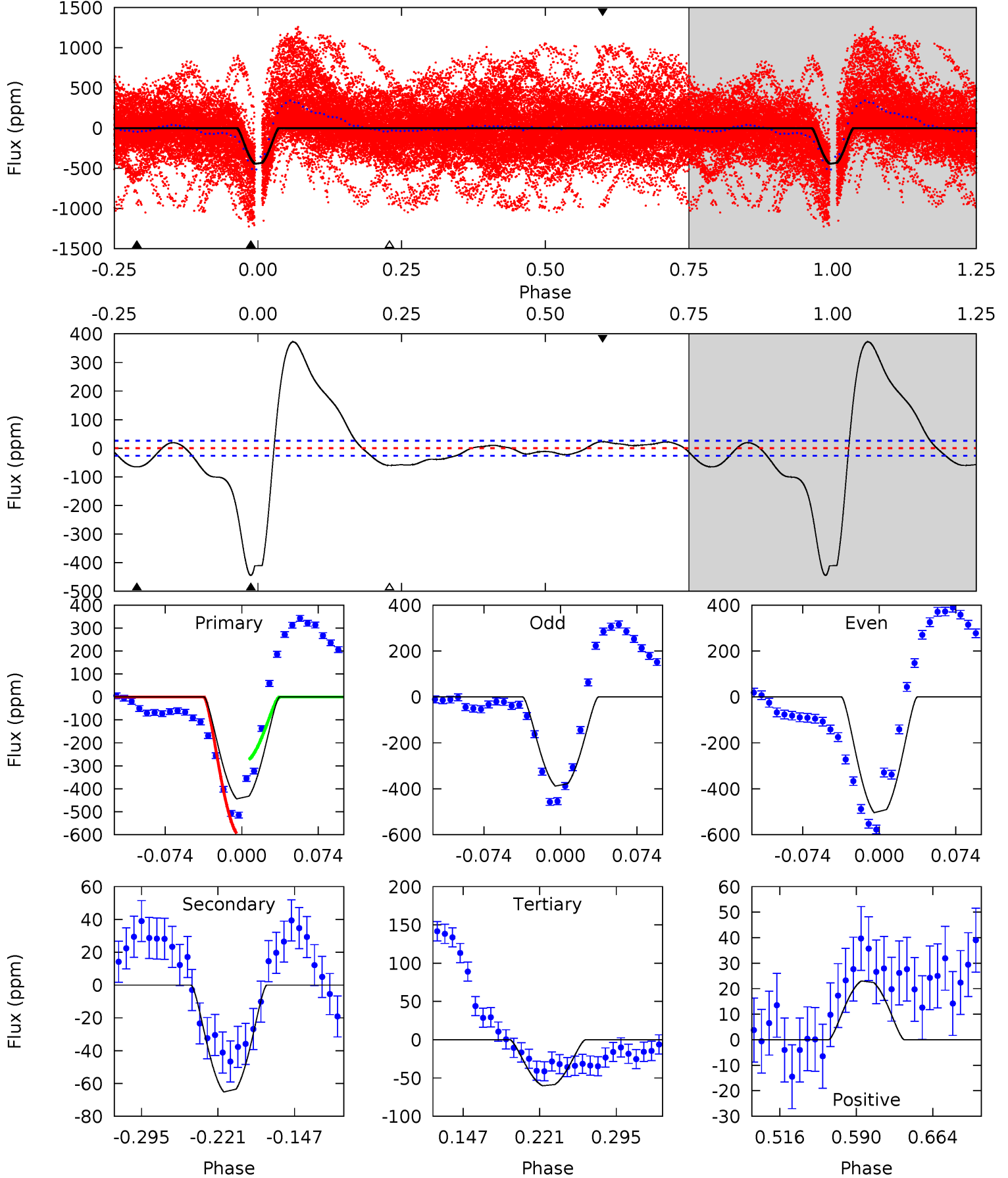




# DV Model-Shift Uniqueness Test

009786821-03, P = 21.119584 Days, E = 129.002164 Days

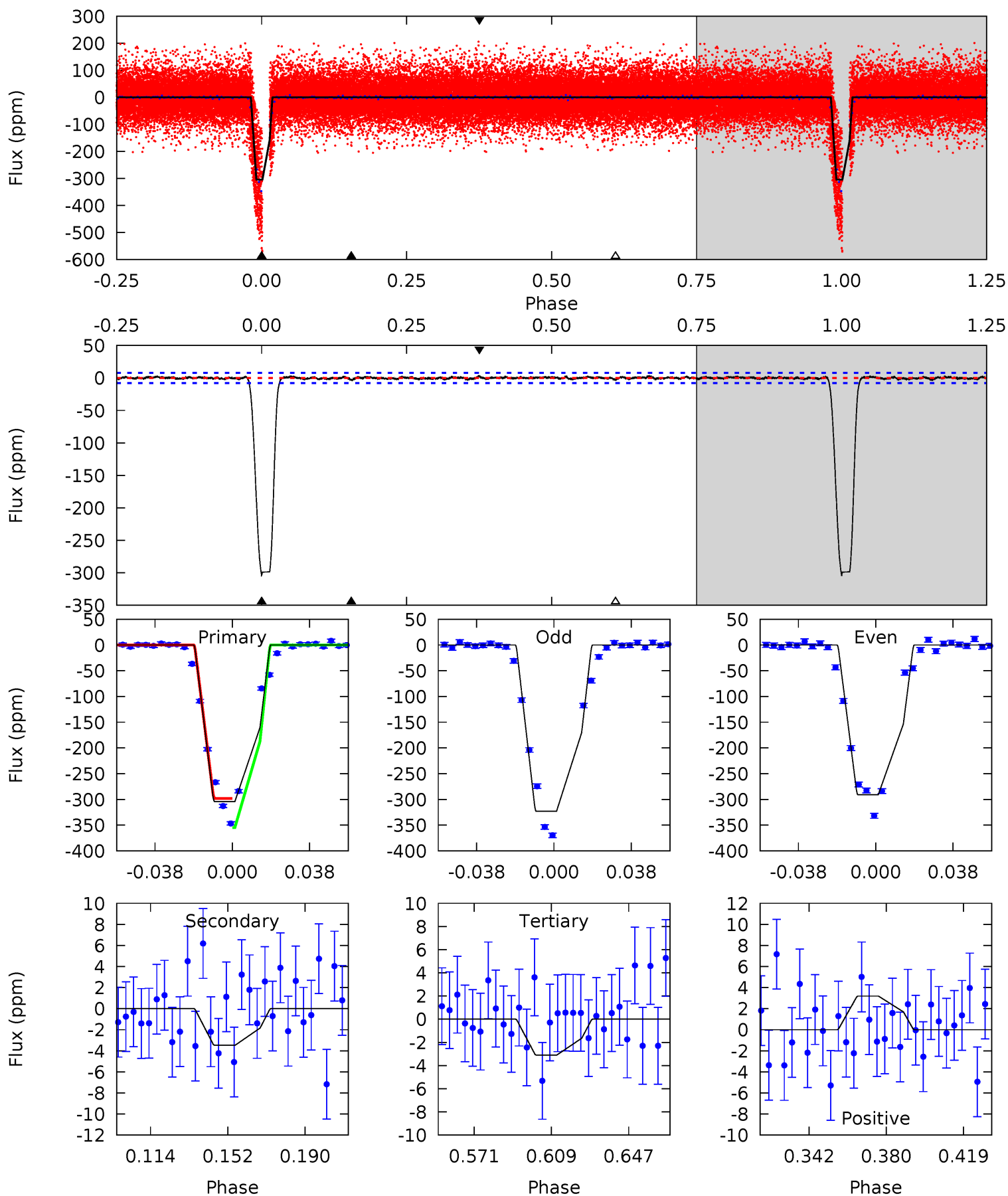
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
78.2	11.5	10.6	4.06	4.63	1.79	15.2	67.6	74.2	0.89	7.42	10.2	1.15	0.46	30.2



# Alt Model-Shift Uniqueness Test

009786821-03, P = 21.120410 Days, E = 128.838389 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
183.0	2.09	1.87	1.92	4.76	2.07	0.57	181.1	181.1	0.23	0.17	9.63	0.89	0.01	0





### Stellar Parameters For KIC 009786821

	$T_{\text{eff}} (K)$	$\log(g)$	$[\text{Fe}/\text{H}]$	$R (R_{\odot})$	$M (M_{\odot})$	$\rho_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$6195^{+199}_{-243}$	$4.069^{+0.306}_{-0.165}$	$-0.200^{+0.250}_{-0.300}$	$1.598^{+0.440}_{-0.538}$	$1.090^{+0.177}_{-0.159}$	$0.377^{+0.865}_{-0.167}$
	+3%/-4%	+8%/-4%	+125%/-150%	+28%/-34%	+16%/-15%	+230%/-44%
Source	PHO54	PHO54	PHO54	DSEP		

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

### Secondary Eclipse Parameters for KIC 009786821-03 / KOI

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{\text{max}} (K)$	$T_{\text{obs}} (K)$	$A_{\text{obs}}$
DV	$-65 \pm 6$	$6.05^{+2.25}_{-2.16}$	$1217^{+99}_{-114}$	$3431^{+479}_{-282}$	$24^{+34}_{-11}$
Alt.	$-3 \pm 2$	$2.94^{+1.93}_{-1.66}$	$1213^{+103}_{-121}$	$2747^{+802}_{-447}$	$5.038^{+23.251}_{-3.555}$

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

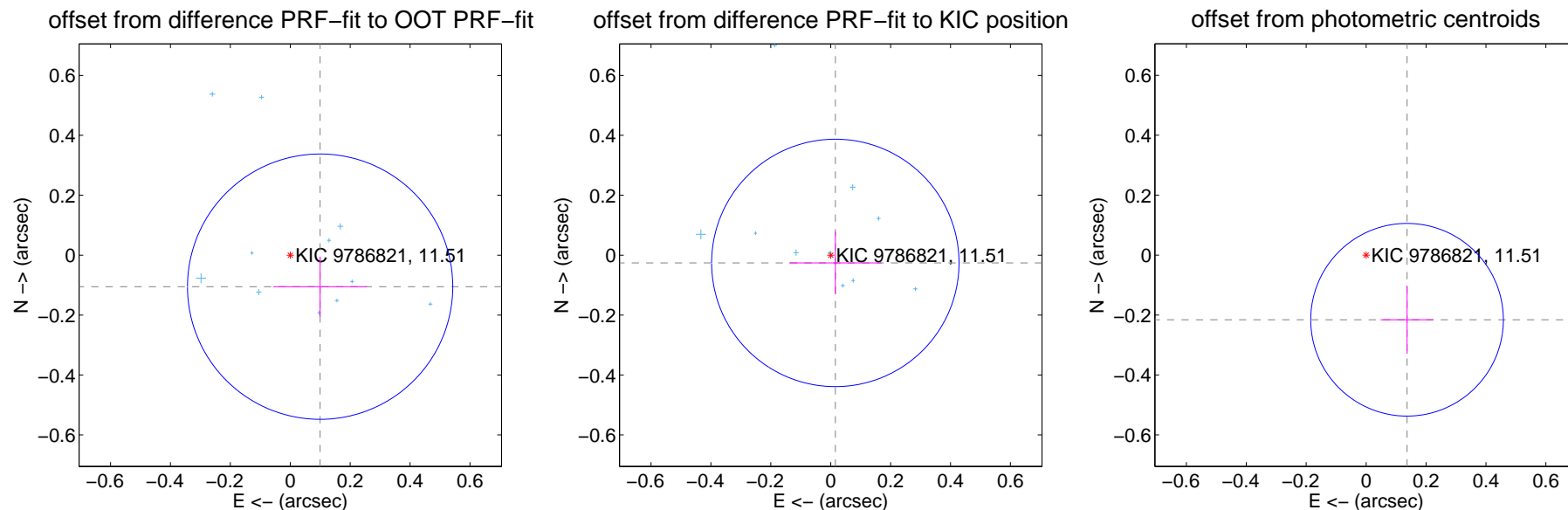
## DV Centroid Data

Supplemental centroid analysis for 009786821-03. **Kepler magnitude: 11.51.** Transit SNR 24.05

There are 13 quarters with good PRF difference image offsets

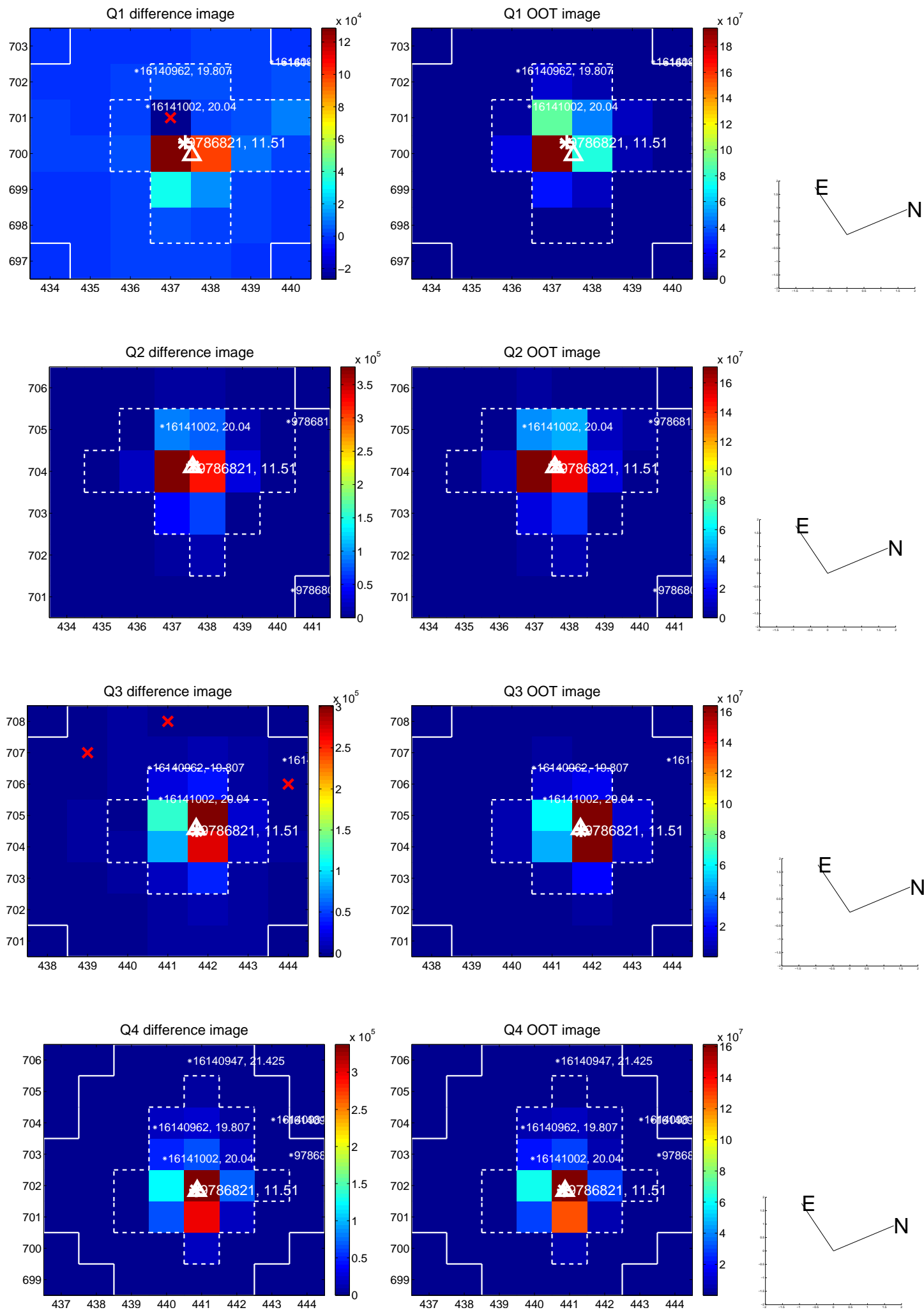
The direct PRF centroid is offset from the target star catalog position by about 0.20 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.145 \pm 0.148$	0.98	$-0.100 \pm 0.156$	$-0.105 \pm 0.100$
PRF-fit source offset from KIC position	$0.030 \pm 0.138$	0.22	$-0.015 \pm 0.154$	$-0.026 \pm 0.105$
photometric centroid source offset	$0.26 \pm 0.11$	2.38	$-0.14 \pm 0.09$	$-0.22 \pm 0.11$

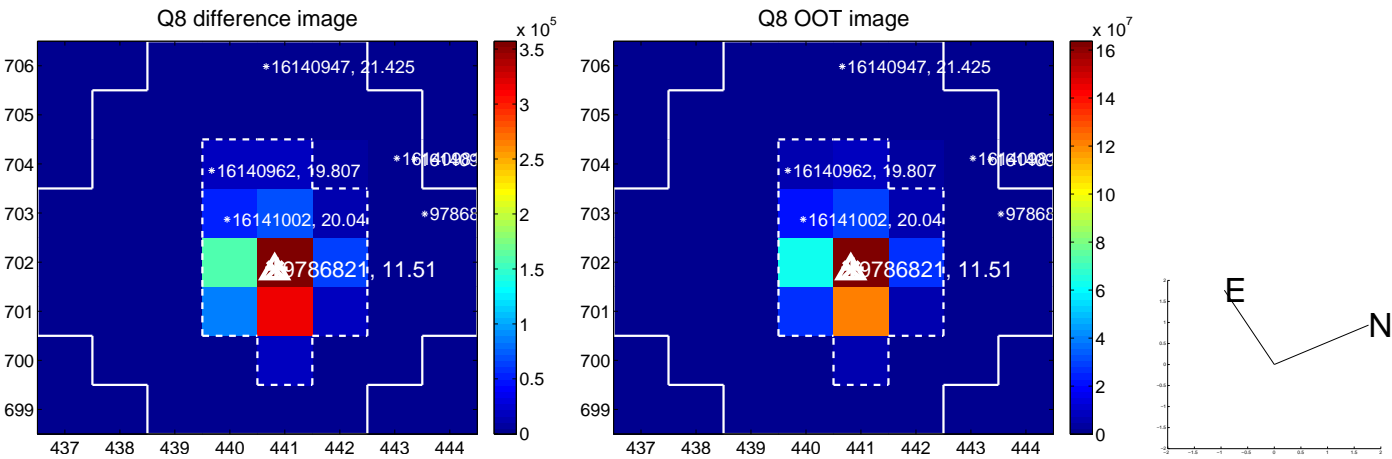
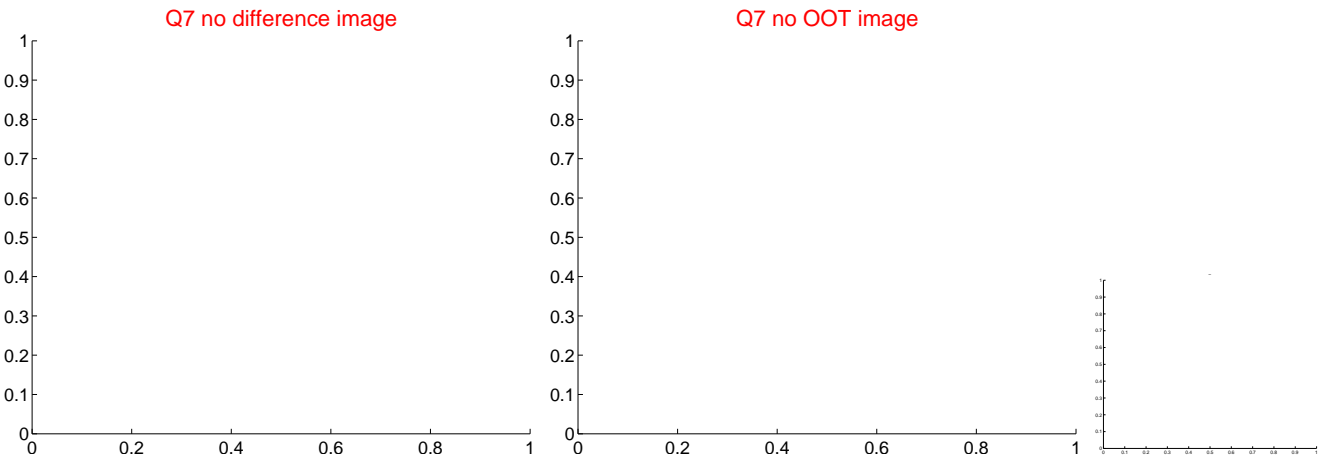
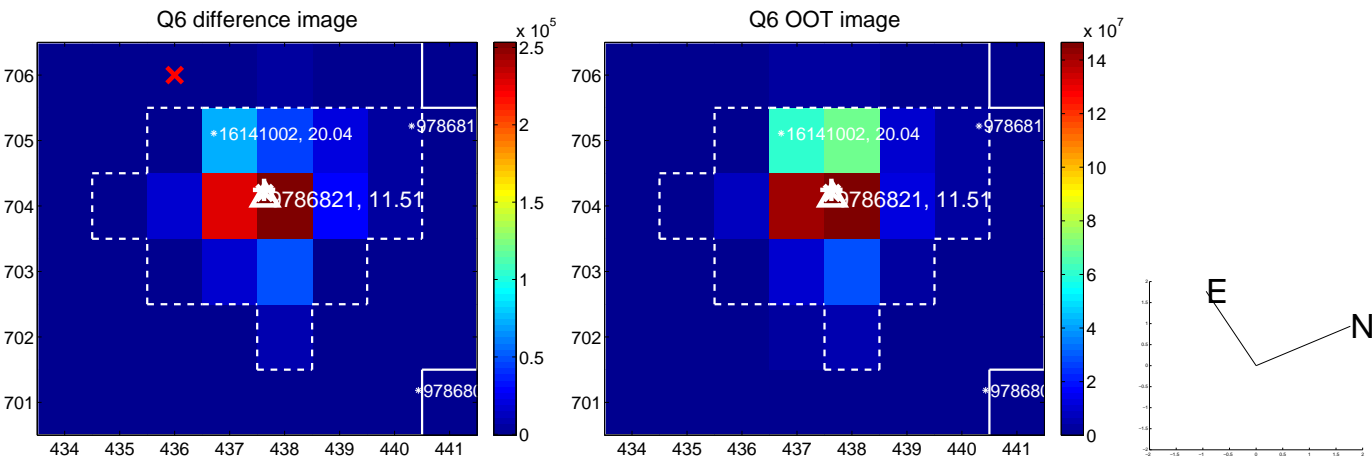
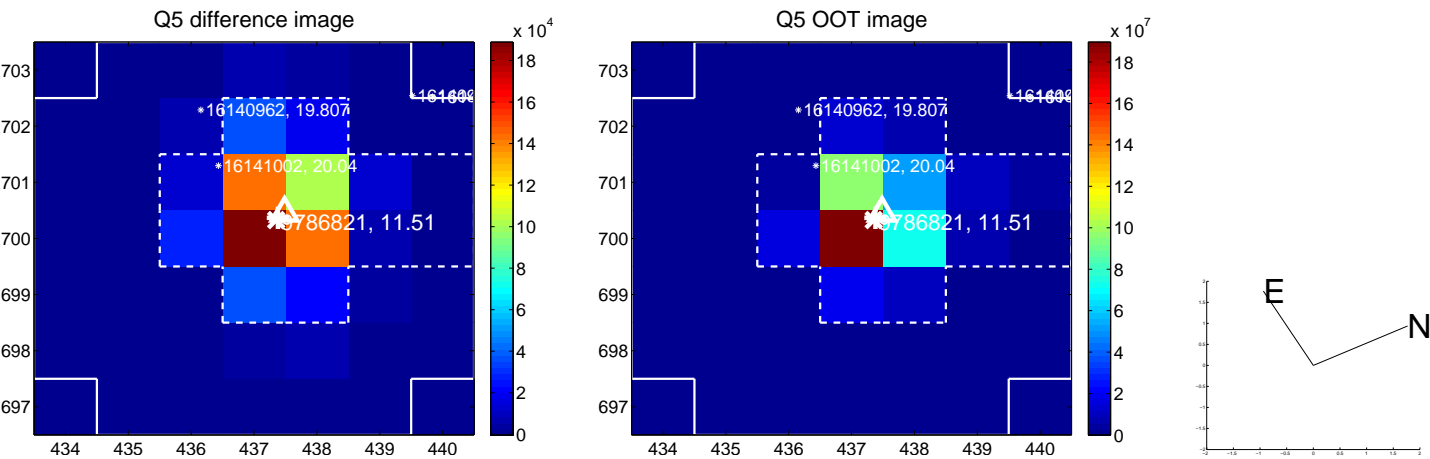


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets;** magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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

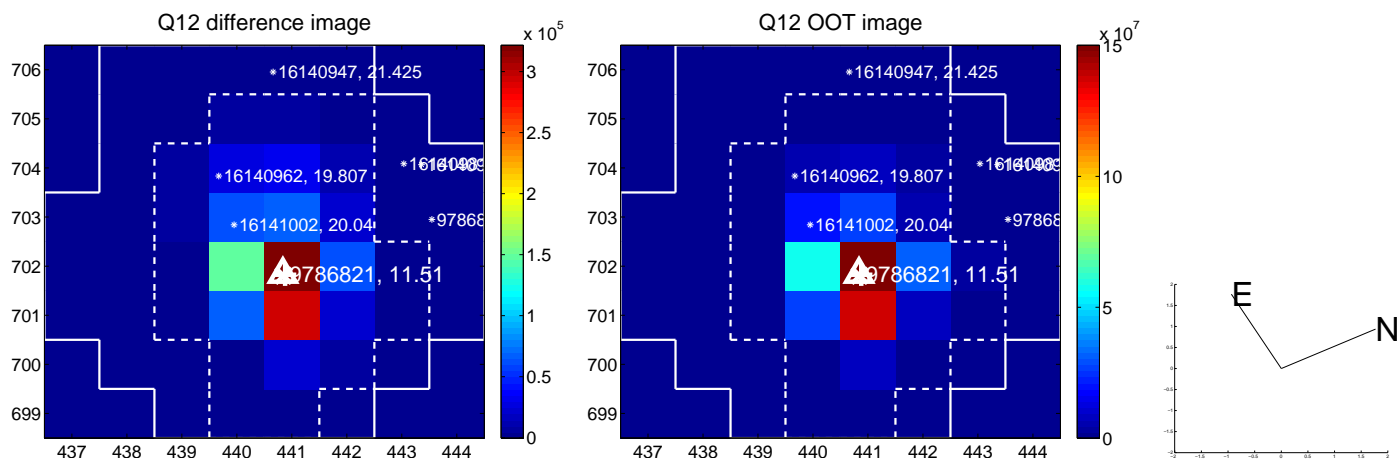
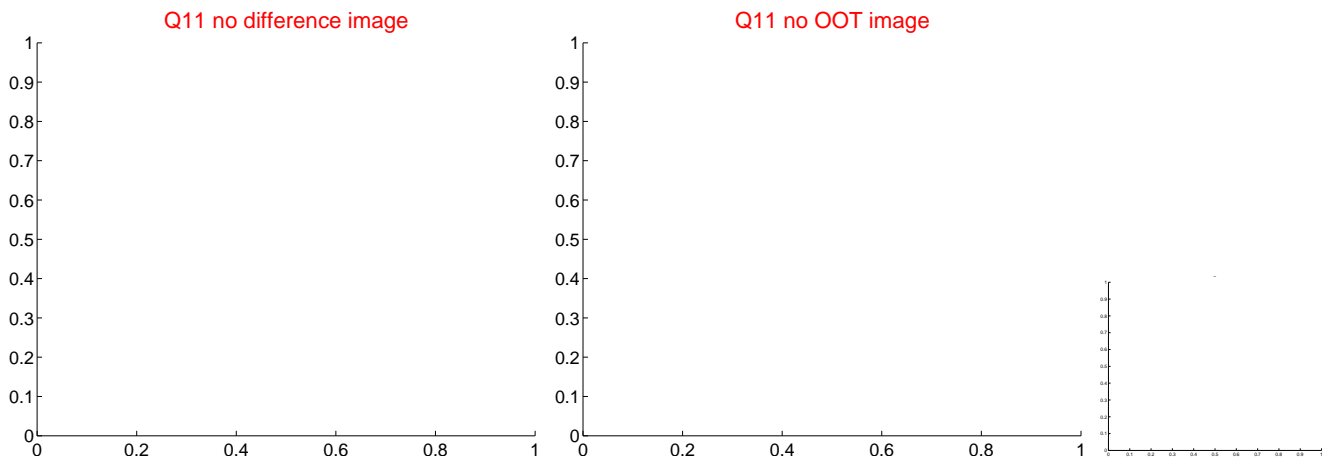
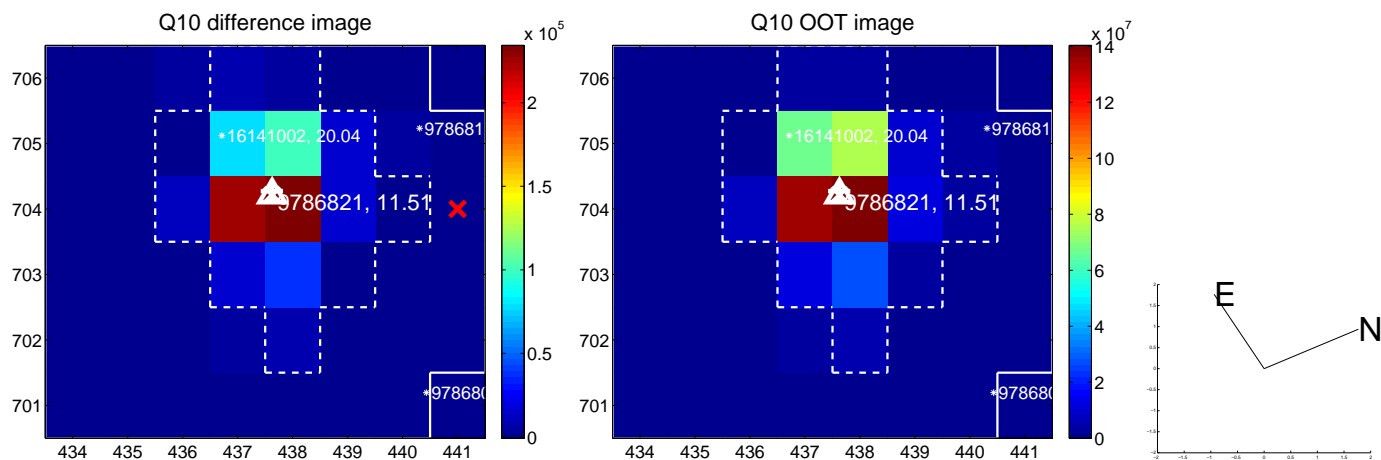
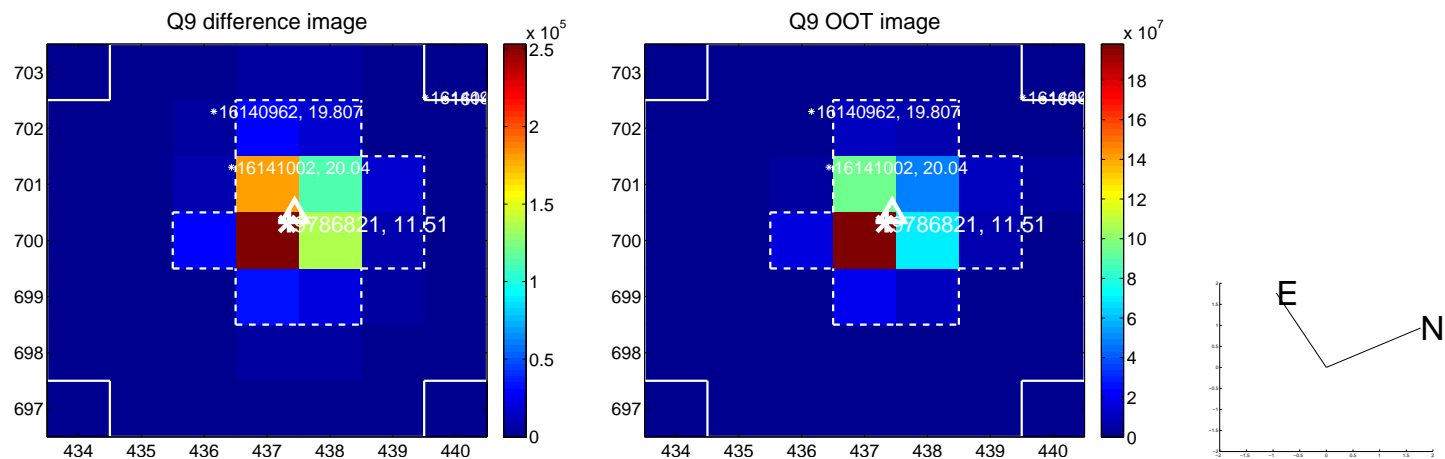
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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.

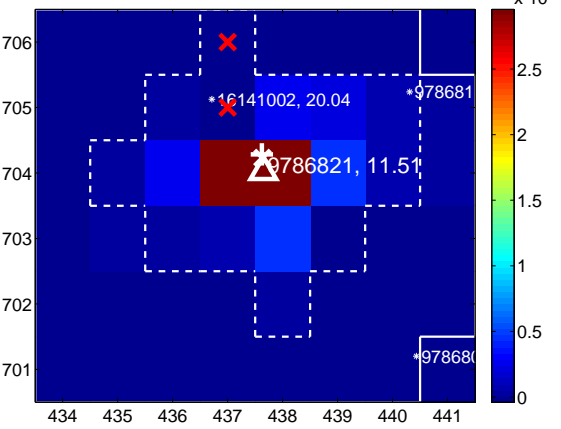
Q13 no difference image



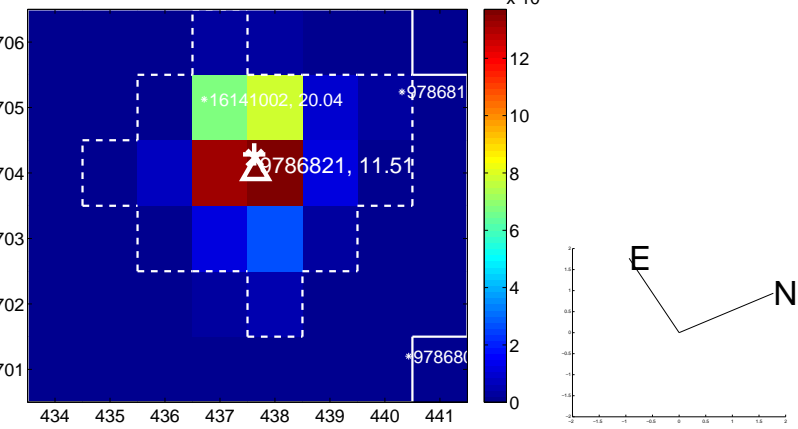
Q13 no OOT image



Q14 difference image



Q14 OOT image



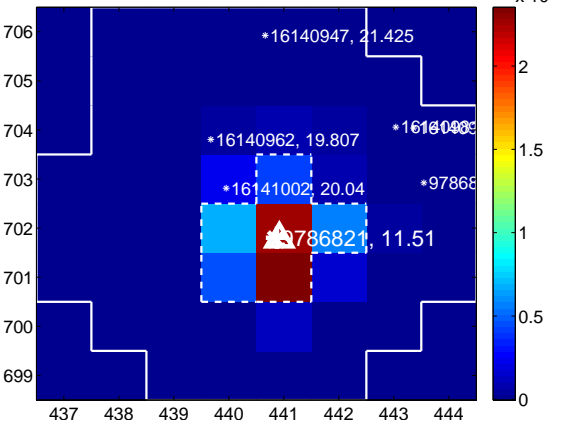
Q15 no difference image



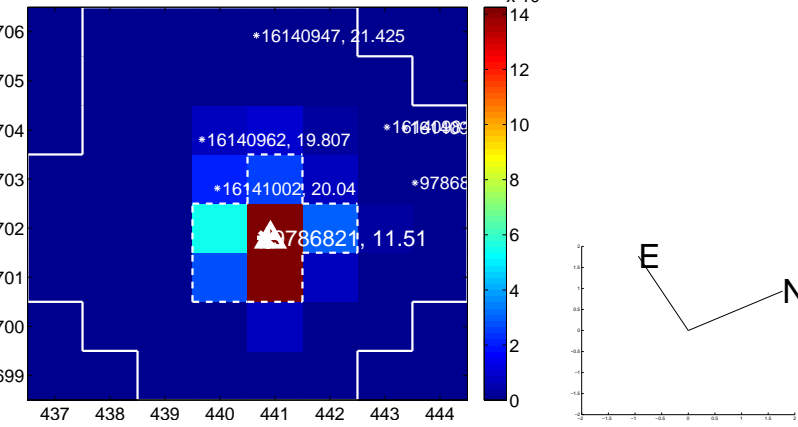
Q15 no OOT image



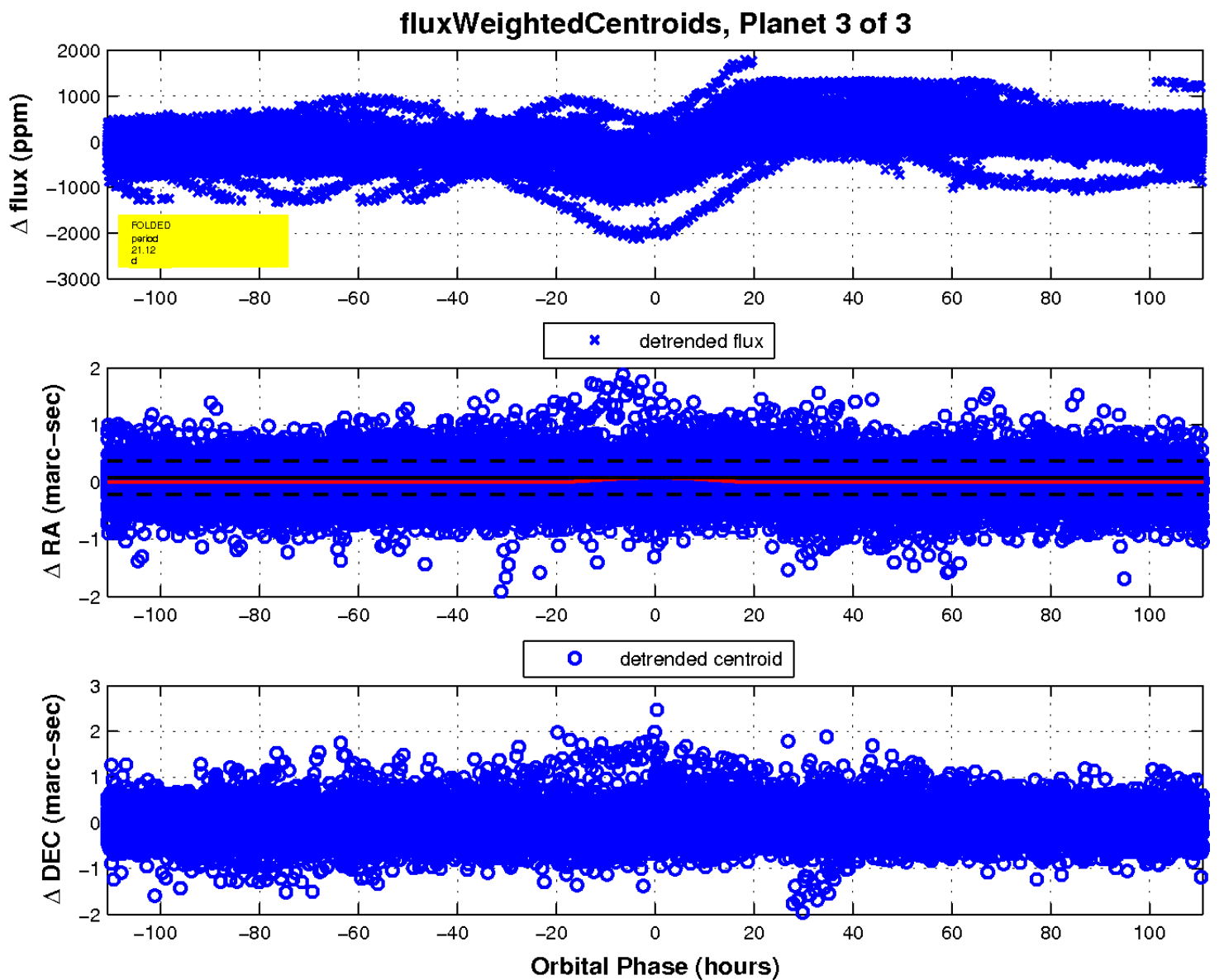
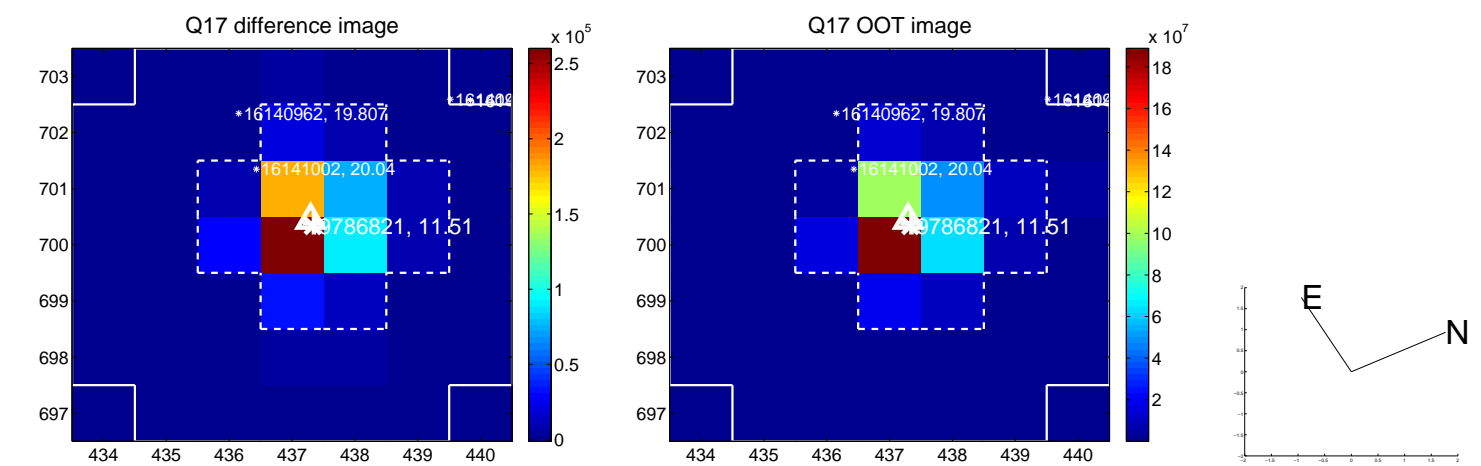
Q16 difference image



Q16 OOT image



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



UKIRT Image

Declination

