

# KIC 010220209

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
010220209-01	OBS	No	5.299195	132.672201	62.1	9.580	7.2	5.9	2.84	14652	2.50	44437.31
010220209-02	OBS	No	7.065052	132.176184	99.8	9.678	7.6	7.6	2.84	14652	3.21	30283.57

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
010220209-01	OBS	FP	0.00	1	0	0	0	LPP_DV—MOD_NONUNIQ_DV
010220209-02	OBS	FP	0.00	1	0	0	0	LPP_DV

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

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

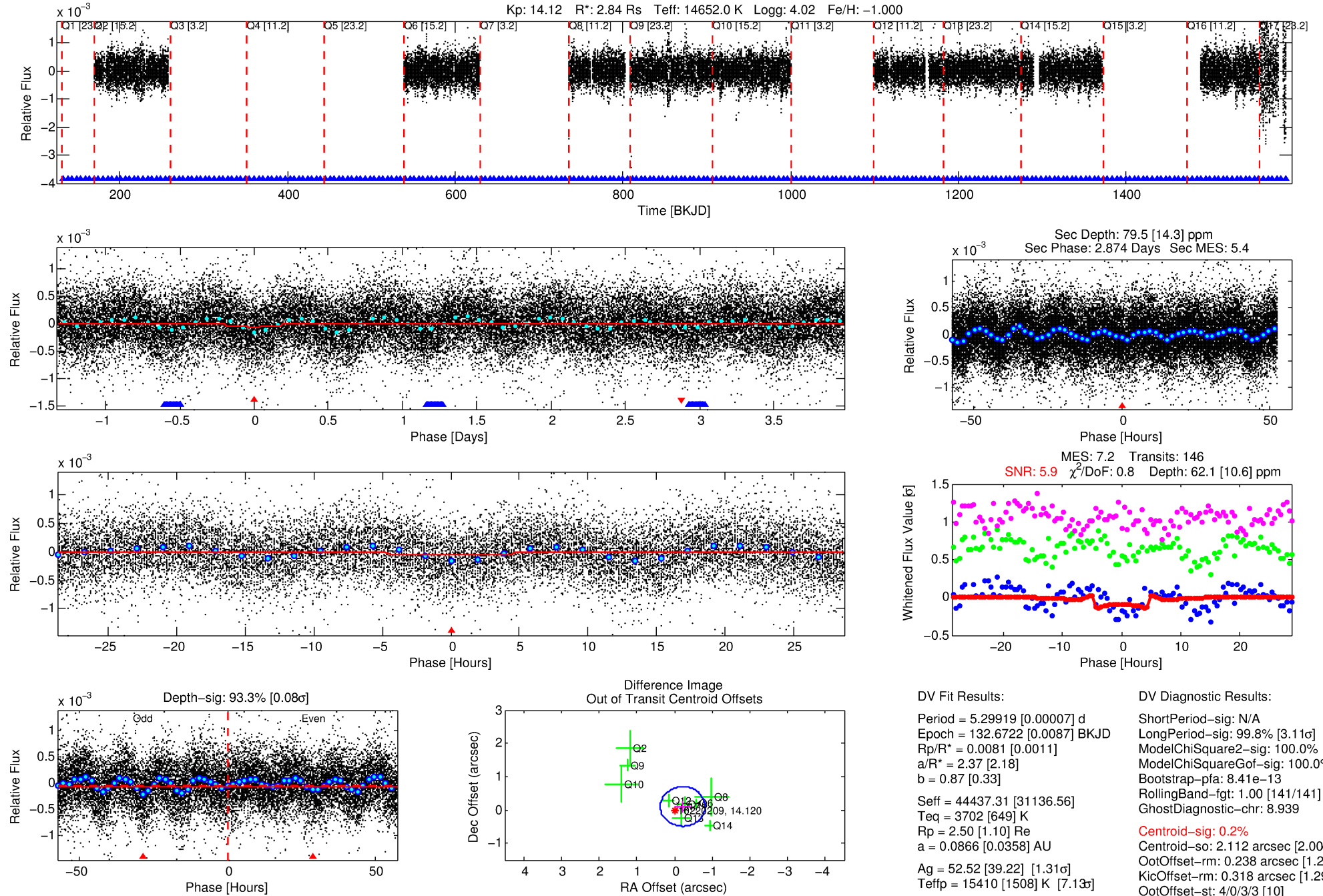
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 010220209-01

No Significant Match Found

# DV One-Page Summary

KIC: 10220209 Candidate: 1 of 2 Period: 5.299 d



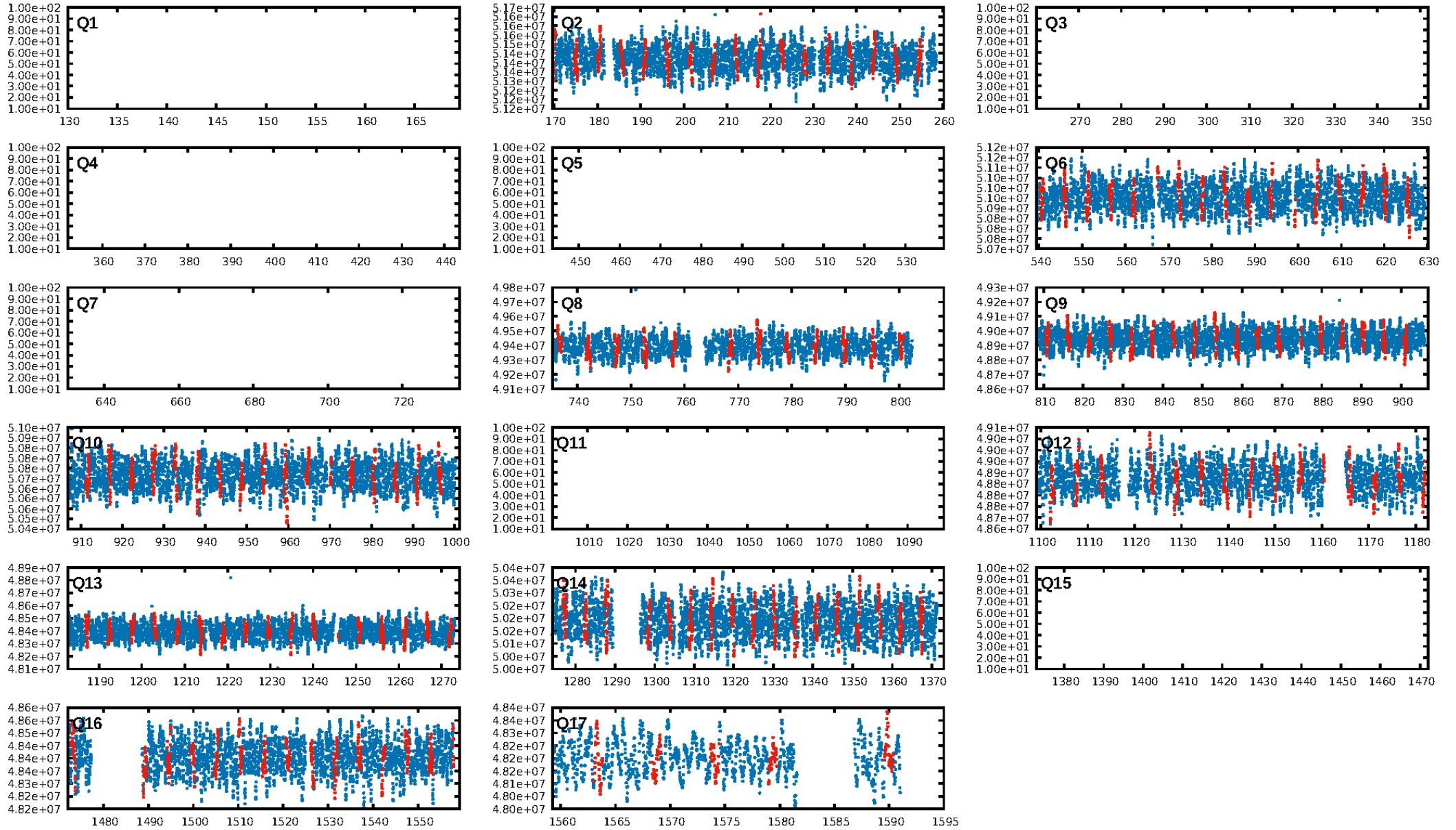
## DV Fit Results:

Period = 5.29919 [0.00007] d  
Epoch = 132.6722 [0.0087] BKJD  
Rp/R\* = 0.0081 [0.0011]  
a/R\* = 2.37 [2.18]  
b = 0.87 [0.33]  
Seff = 44437.31 [31136.56]  
Teff = 3702 [649] K  
Rp = 2.50 [1.10] Re  
a = 0.0866 [0.0358] AU  
Ag = 52.52 [39.22] [1.31 $\sigma$ ]  
Teffp = 15410 [1508] K [7.13 $\sigma$ ]

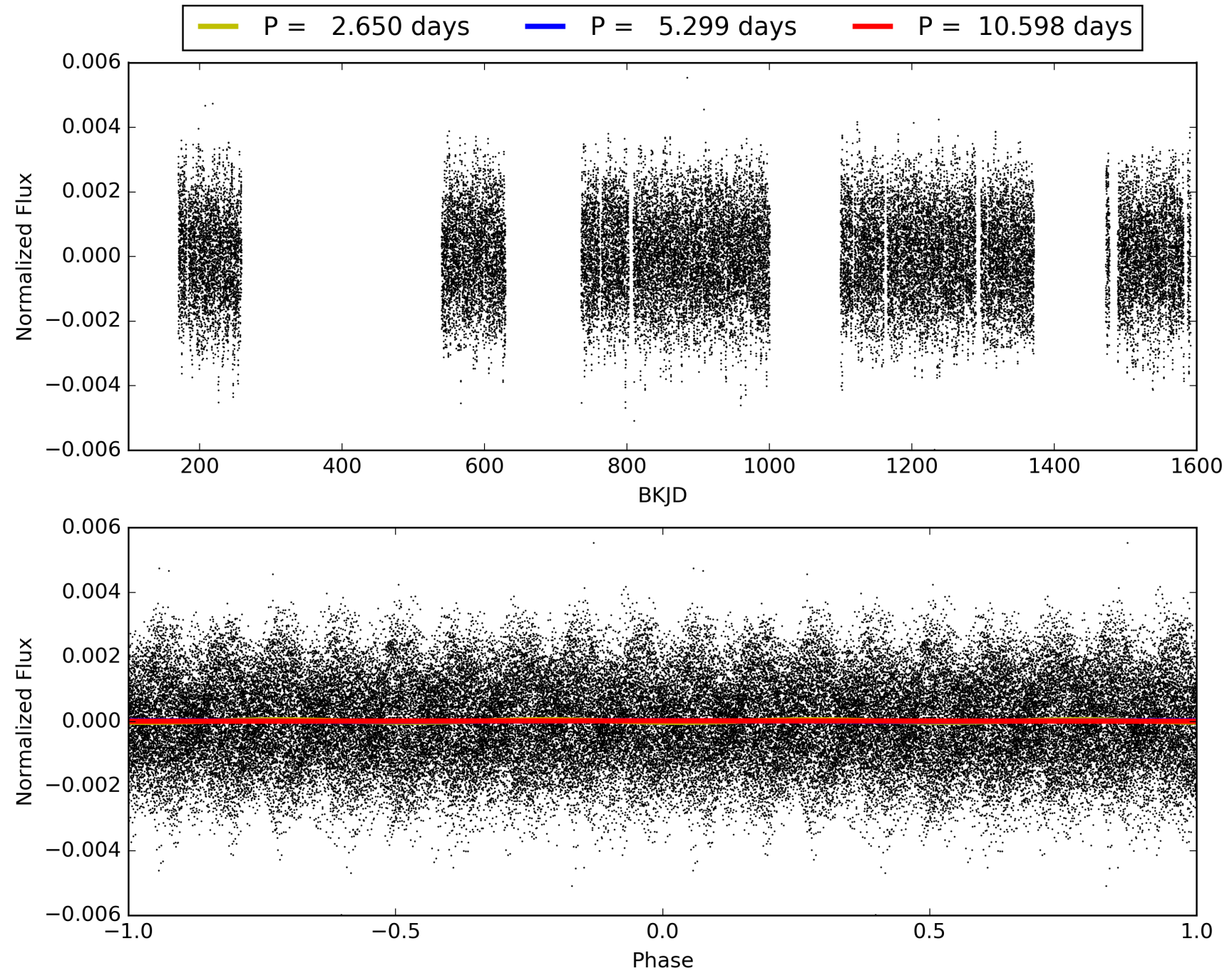
## DV Diagnostic Results:

ShortPeriod-sig: N/A  
LongPeriod-sig: 99.8% [3.11 $\sigma$ ]  
ModelChiSquare2-sig: 100.0%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 8.41e-13  
RollingBand-fgt: 1.00 [141/141]  
GhostDiagnostic-chr: 8.939  
Centroid-sig: 0.2%  
Centroid-so: 2.112 arcsec [2.00 $\sigma$ ]  
OotOffset-rm: 0.238 arcsec [1.21 $\sigma$ ]  
KicOffset-rm: 0.318 arcsec [1.29 $\sigma$ ]  
OotOffset-st: 4/0/3/3 [10]  
KicOffset-st: 4/0/3/3 [10]  
DiffImageQuality-fgm: 0.50 [5/10]  
DiffImageOverlap-fno: 1.00 [10/10]

# TCE 010220209-01, PDC Light Curves

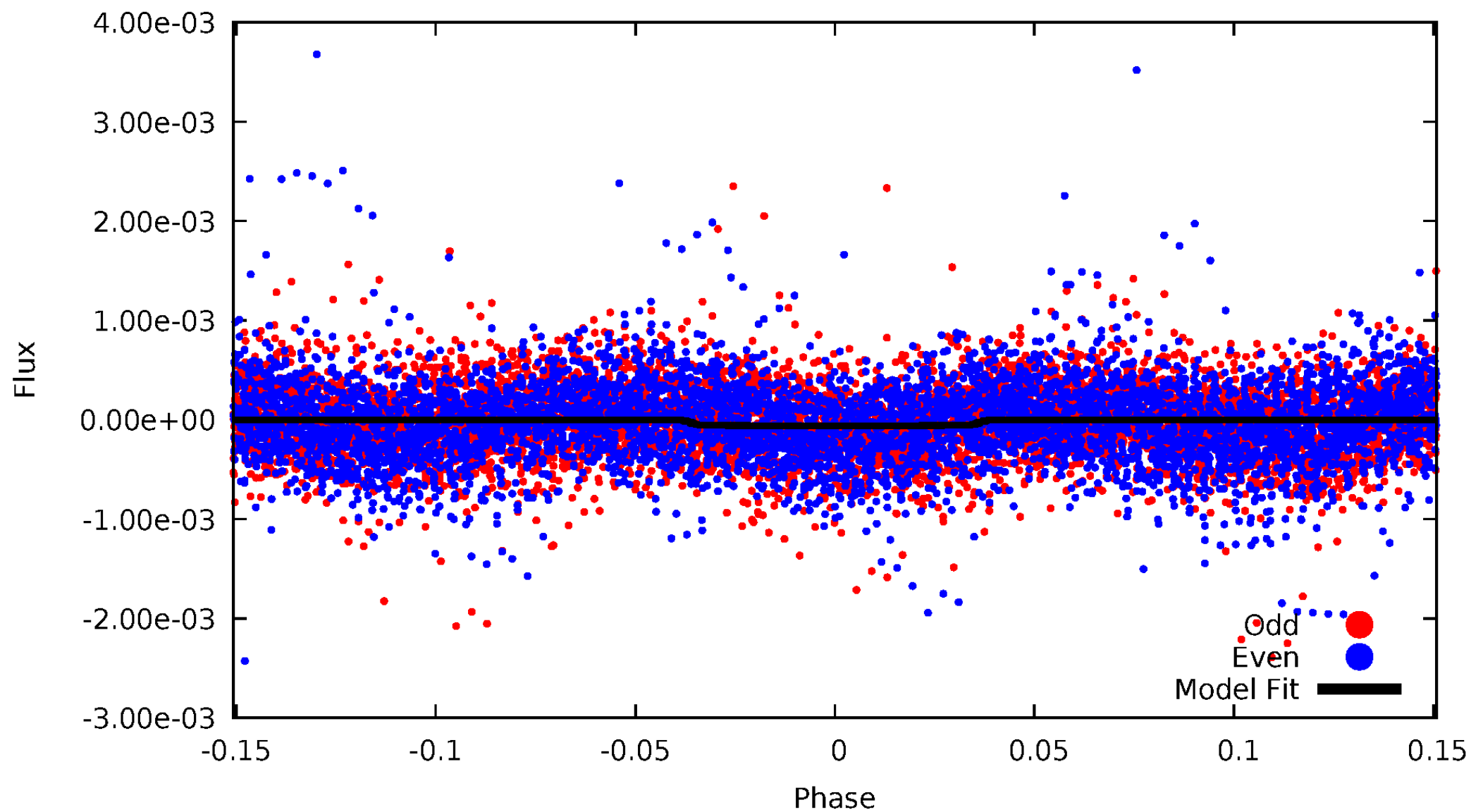


TCE 010220209-01



# DV Odd/Even

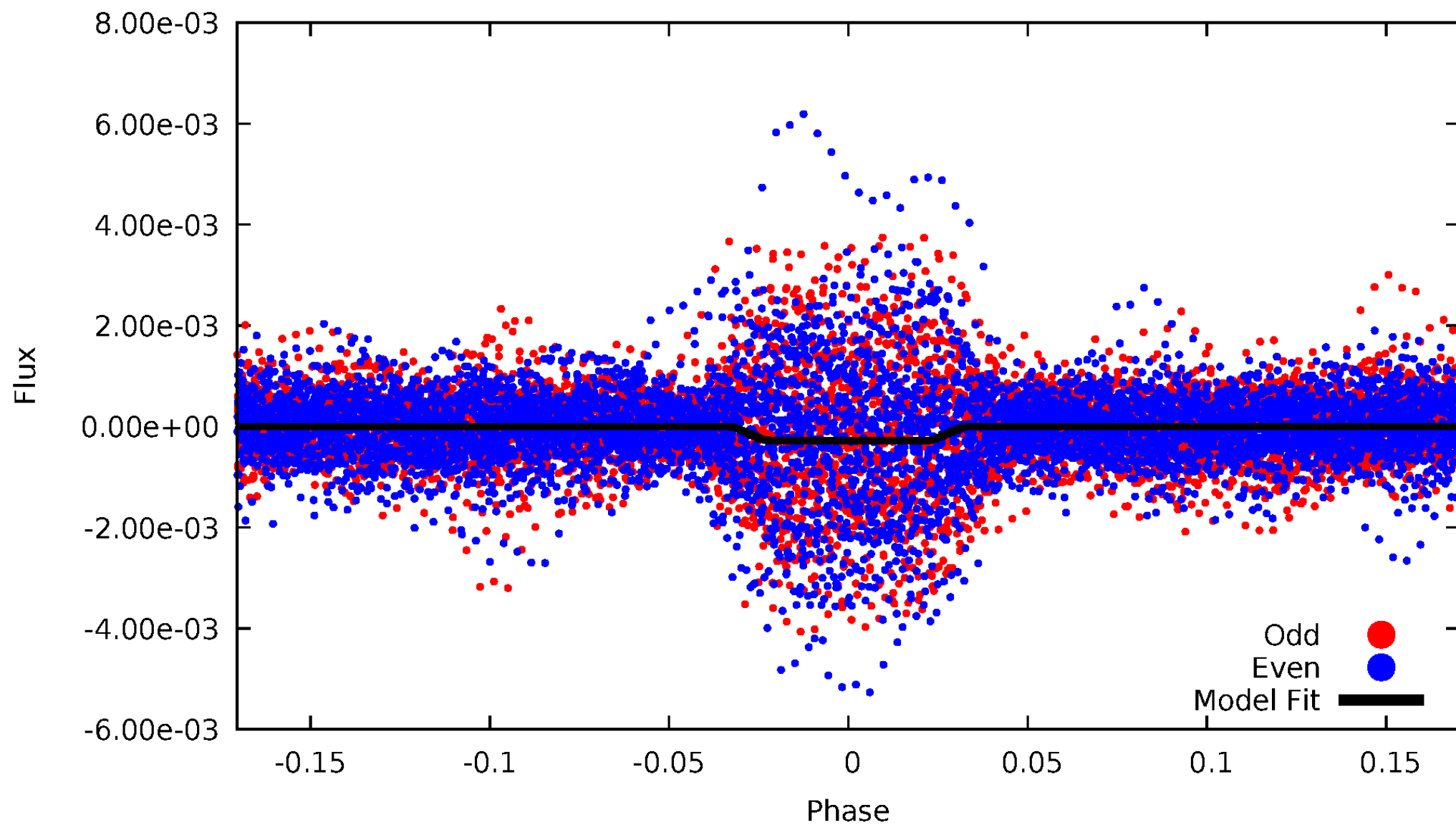
TCE 010220209-01





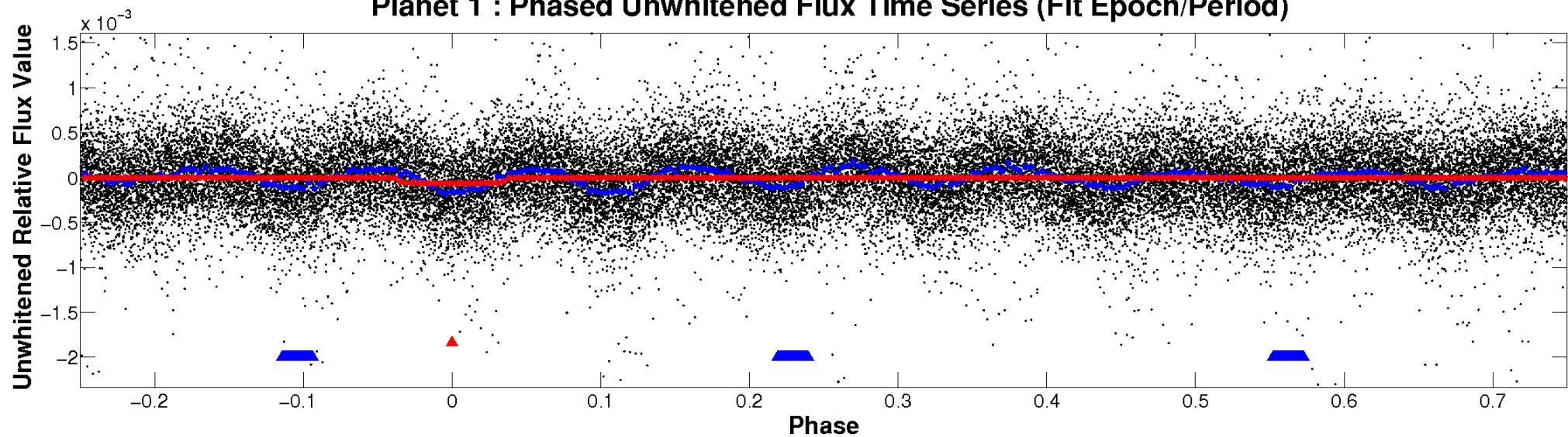
# ALT Odd/Even

TCE 010220209-01

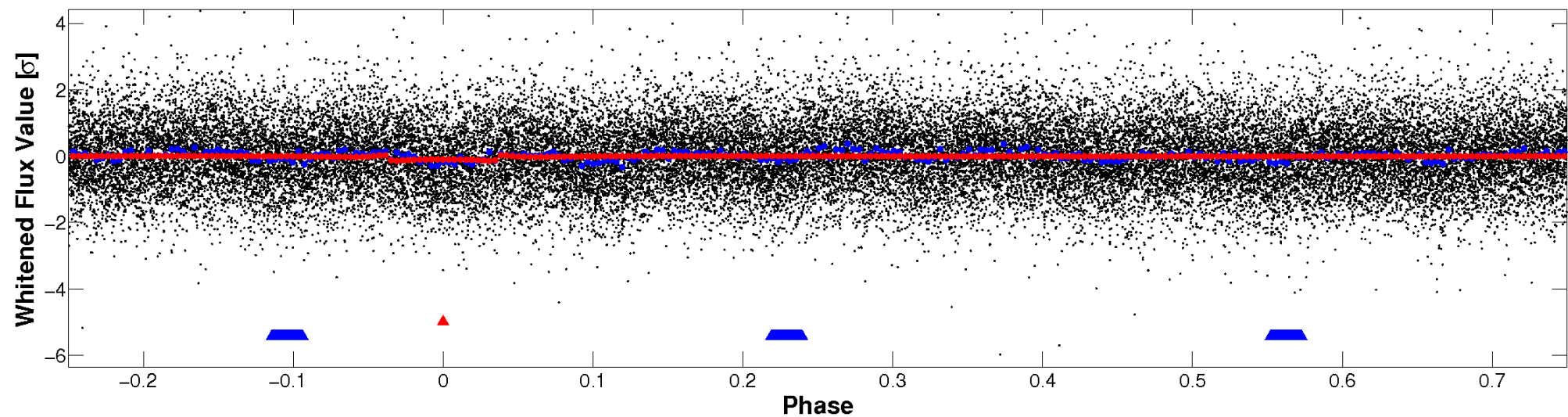


# Non-Whitened Vs. Whitened Light Curve

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

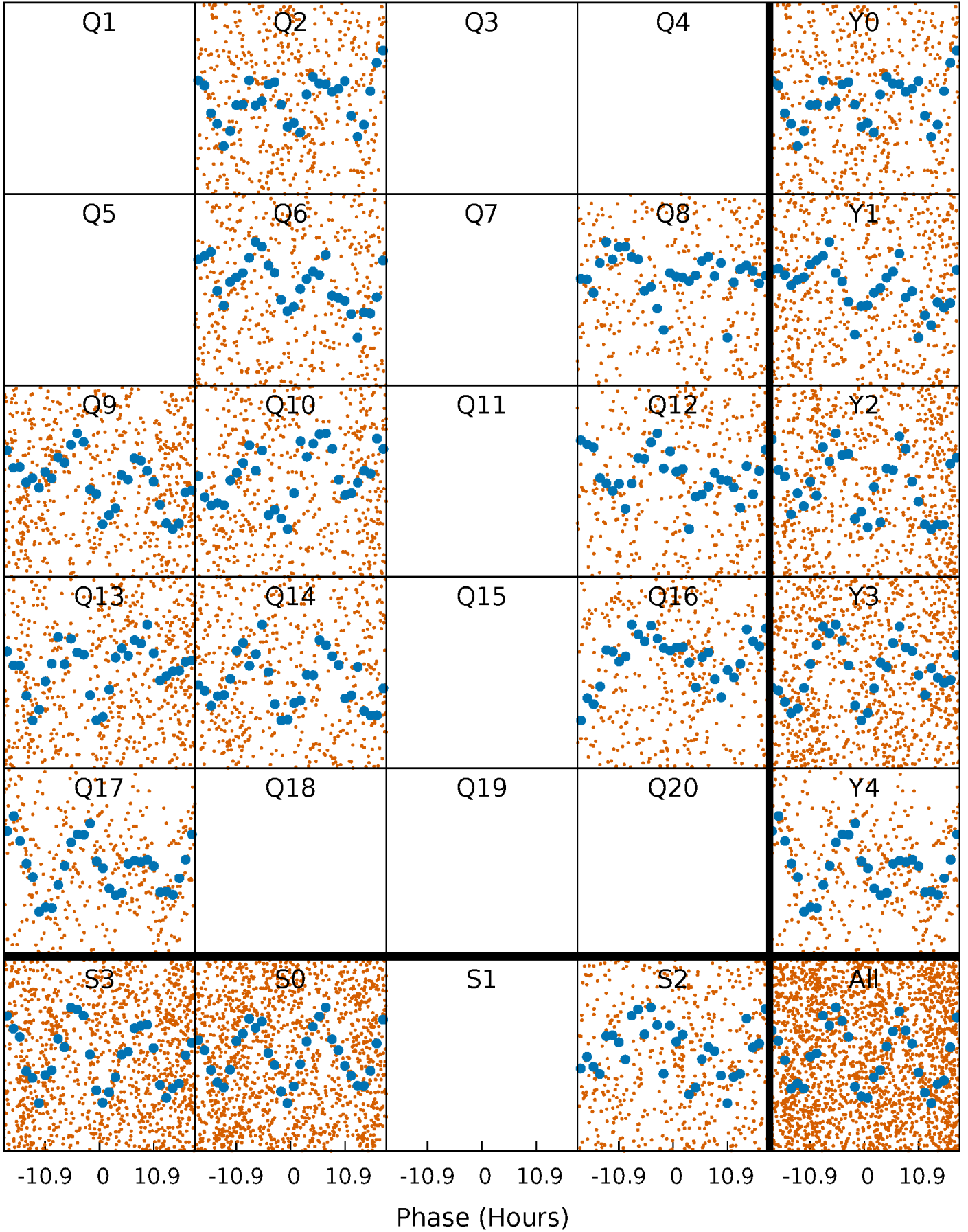


**Planet 1 : Phased Whitened Flux Time Series (Fit Epoch/Period)**



# PDC Quarter-Phased Transit Curves

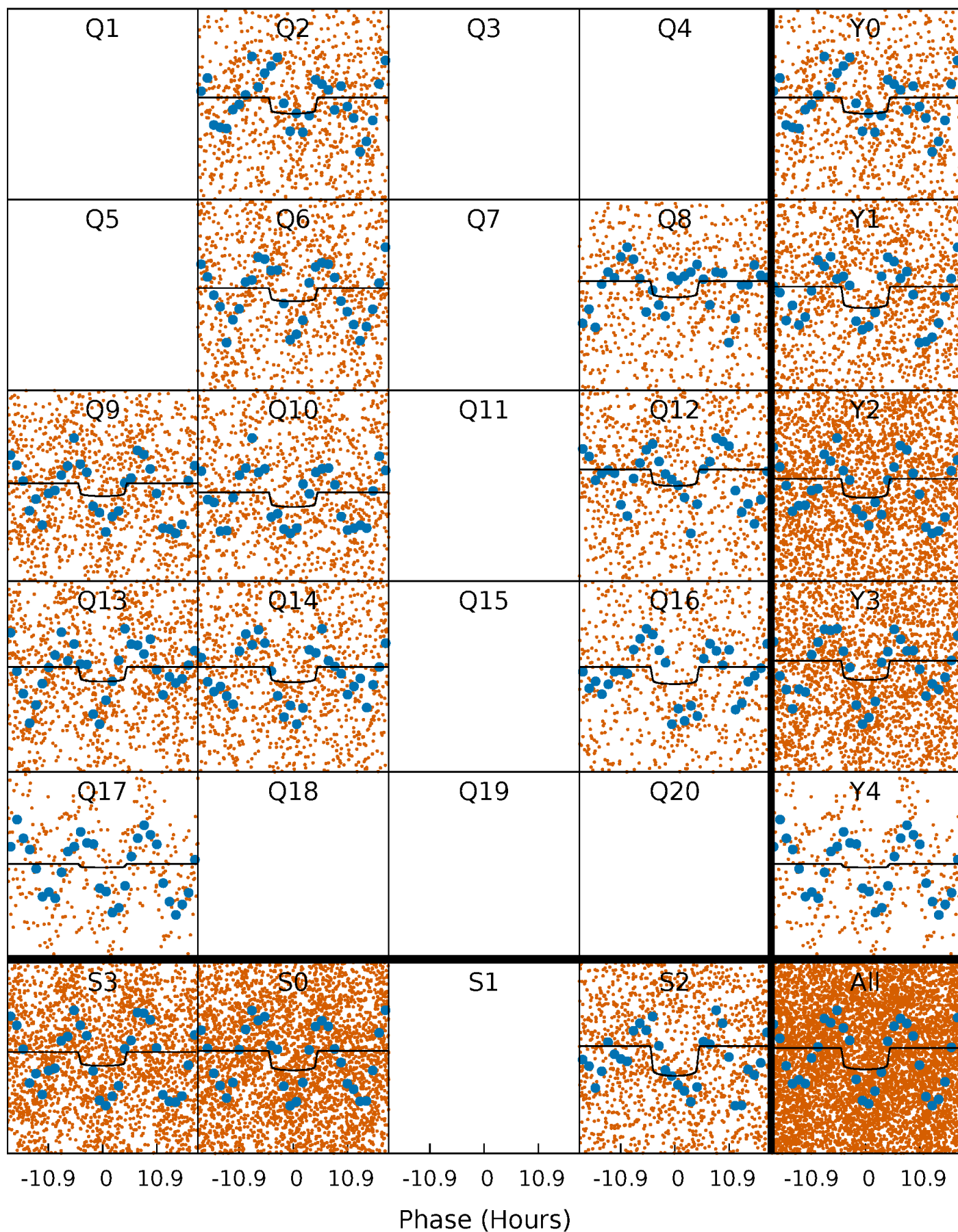
TCE 010220209-01   P= 5.299195 Days    $T_0=132.672201$  (BKJD)





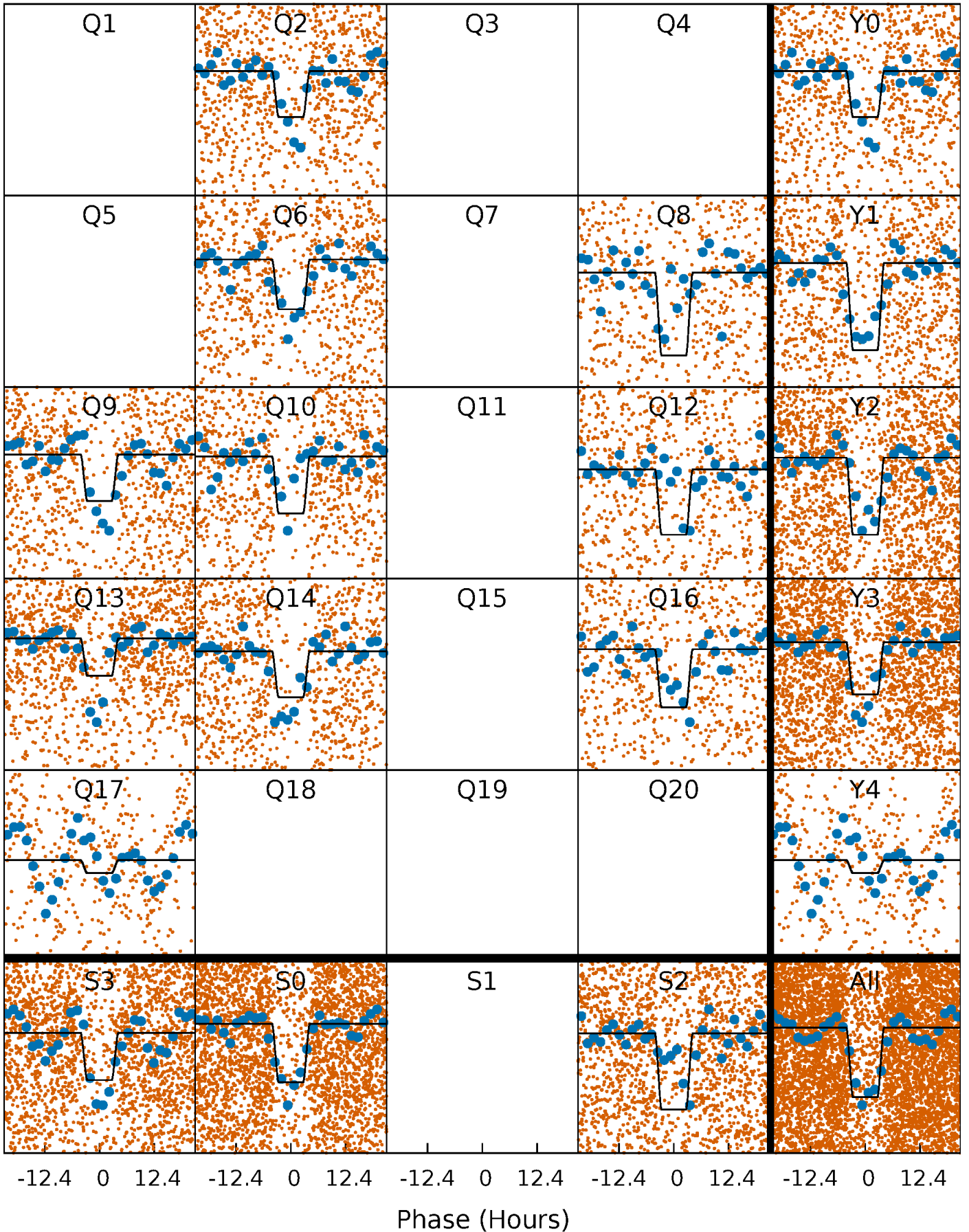
# DV Quarter-Phased Transit Curves

TCE 010220209-01 P= 5.299195 Days  $T_0=132.672201$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

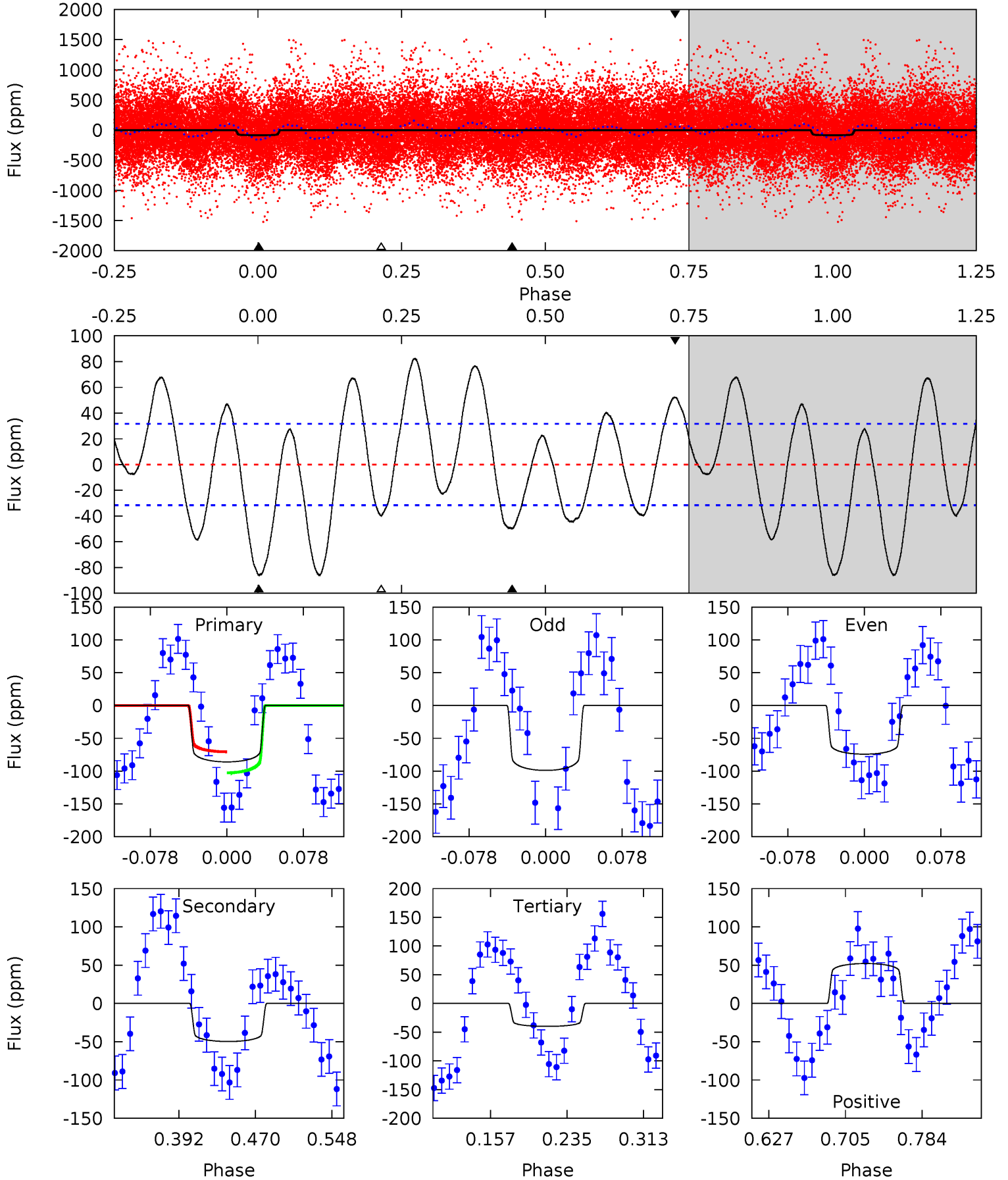
TCE 010220209-01   P= 5.299381 Days    $T_0=132.662322$  (BKJD)



# DV Model-Shift Uniqueness Test

010220209-01, P = 5.299195 Days, E = 132.672201 Days

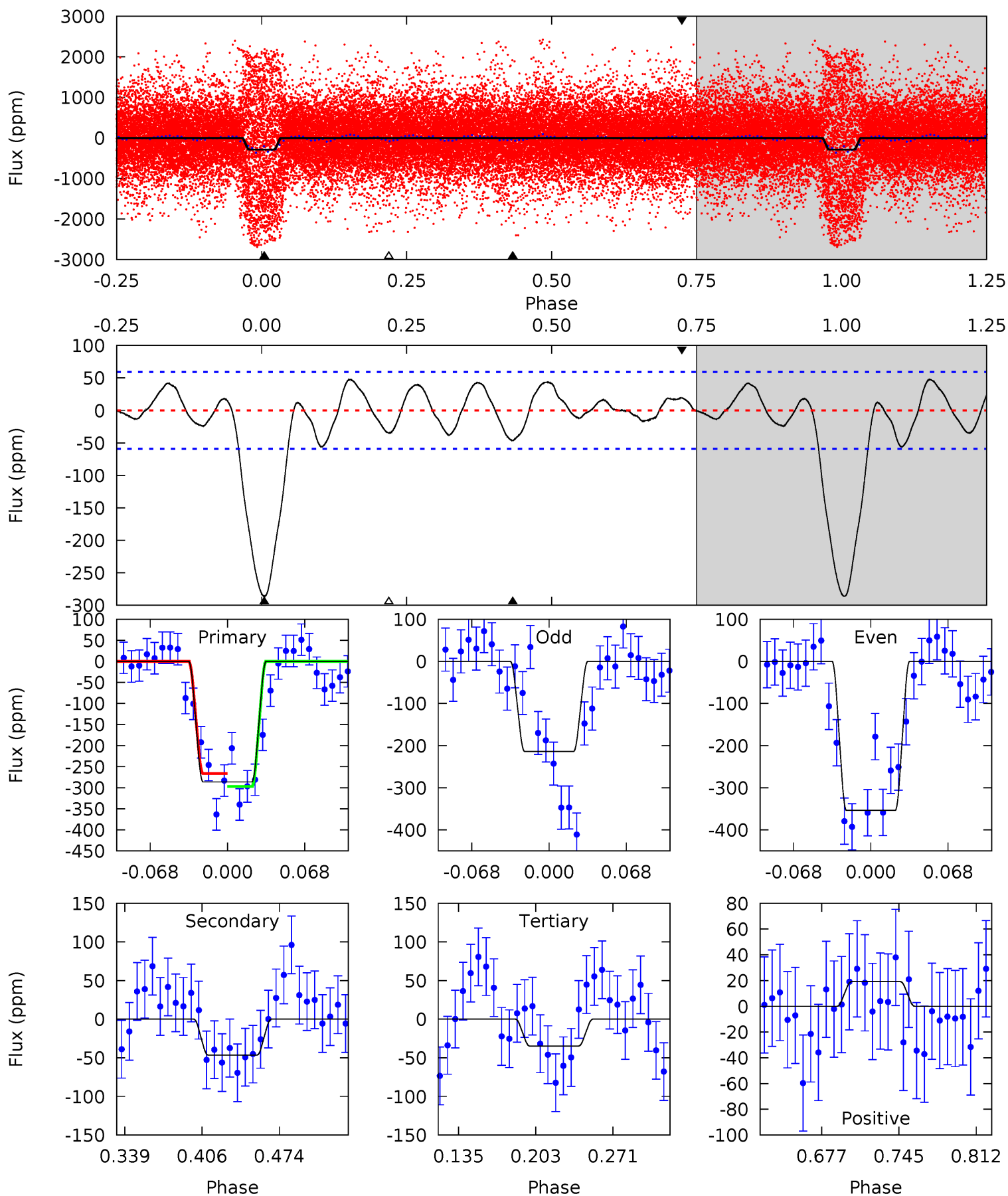
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
12.6	7.25	5.83	7.62	4.62	1.76	5.88	6.72	4.94	1.42	-0.36	1.82	1.05	0.49	2.34



# Alt Model-Shift Uniqueness Test

010220209-01, P = 5.299381 Days, E = 132.662322 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
22.5	3.64	2.73	1.50	4.65	1.83	1.75	19.7	20.9	0.92	2.14	5.41	0.83	0.14	1.19



### Stellar Parameters For KIC 010220209

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R (R_{\odot})$	$M(M_{\odot})$	$p_{\star} (g \cdot \text{cm}^{-3})$
	$14652^{+344}_{-762}$	$4.020^{+0.396}_{-0.008}$	$-1.000^{+0.300}_{-0.300}$	$2.840^{+0.041}_{-1.191}$	$3.080^{+-1.000}_{-0.528}$	$0.189^{+0.632}_{-0.005}$
	+2%/-5%	+10%/-0%	+30%/-30%	+1%/-42%	+32%/-17%	+334%/-3%
Source	KIC0	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 010220209-01 / KOI

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{max} (K)$	$T_{obs} (K)$	$A_{obs}$
DV	$-50 \pm 7$	$2.26^{+0.48}_{-0.47}$	$4940^{+294}_{-520}$	$12785^{+2214}_{-1616}$	$40^{+24}_{-12}$
Alt.	$-46 \pm 13$	$4.86^{+0.55}_{-0.94}$	$4962^{+270}_{-493}$	$7338^{+660}_{-676}$	$8.146^{+4.780}_{-2.453}$

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



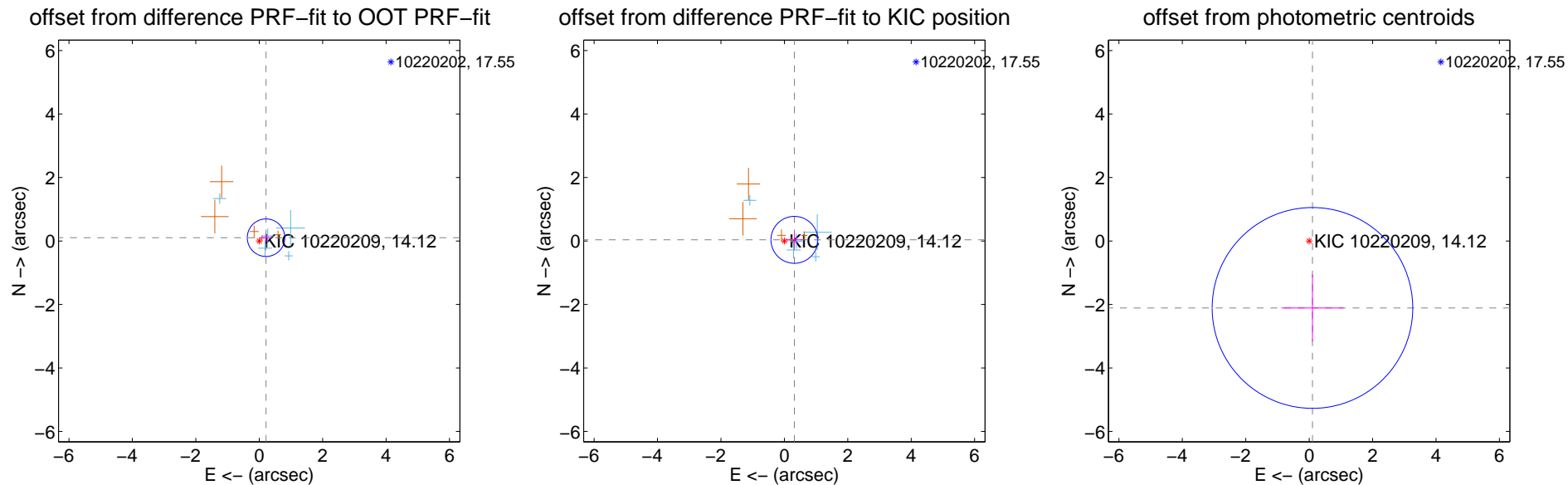
## DV Centroid Data

Supplemental centroid analysis for 010220209-01. Kepler magnitude: 14.12. Transit SNR 5.91

There are 5 quarters with good PRF difference image offsets

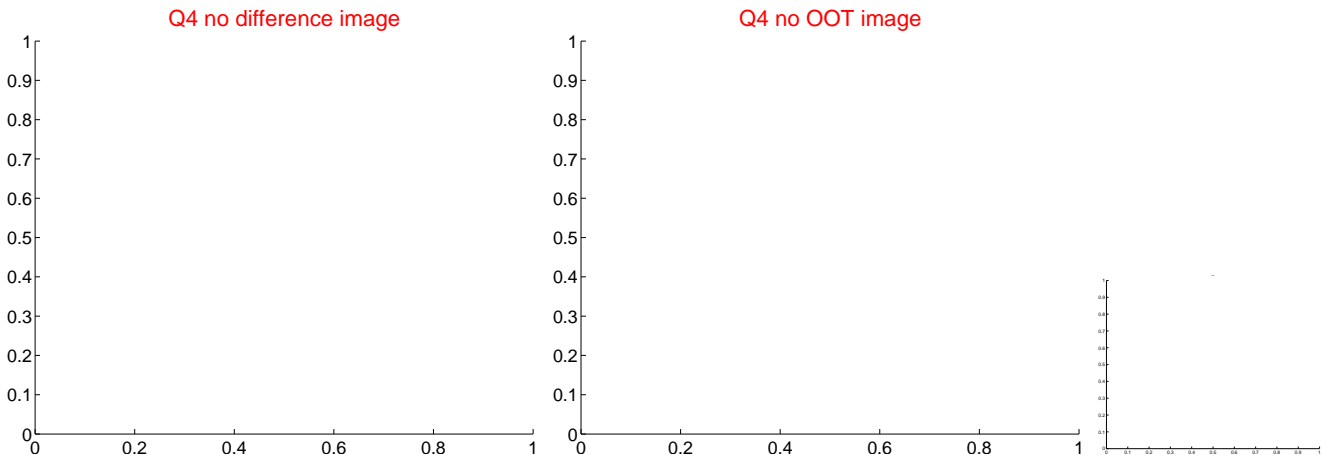
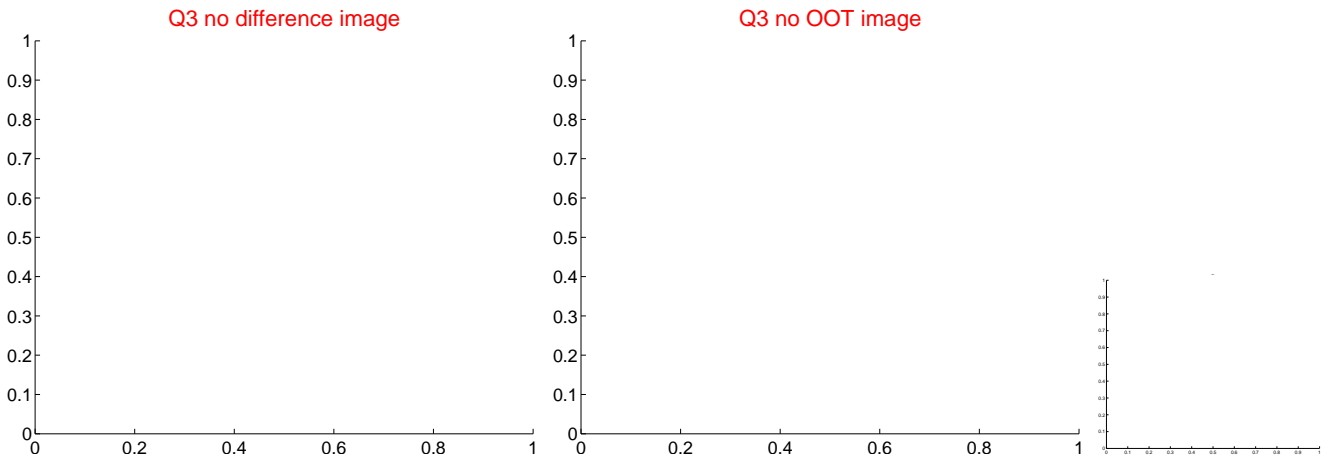
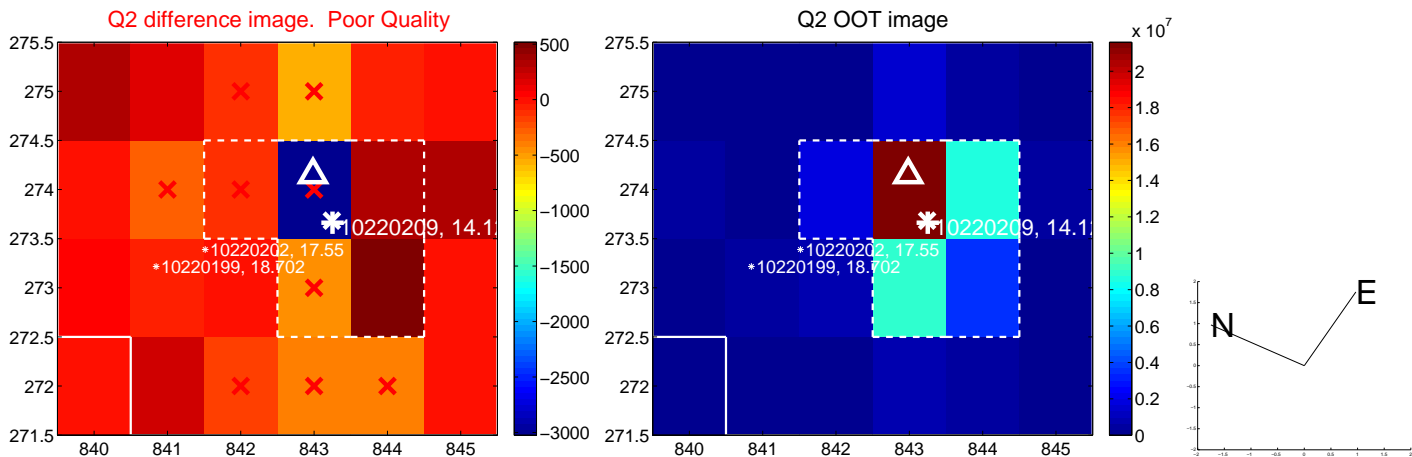
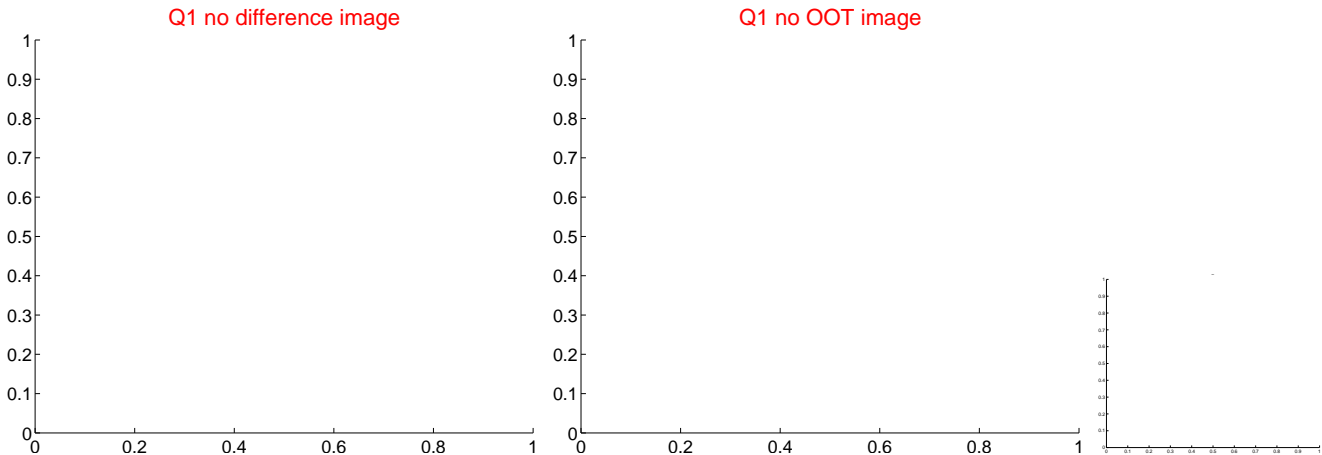
The direct PRF centroid is offset from the target star catalog position by about 0.17 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.238 \pm 0.197$	1.21	$-0.215 \pm 0.208$	$0.104 \pm 0.142$
PRF-fit source offset from KIC position	$0.318 \pm 0.246$	1.29	$-0.316 \pm 0.267$	$0.036 \pm 0.228$
photometric centroid source offset	$2.11 \pm 1.05$	2.00	$-0.10 \pm 0.98$	$-2.11 \pm 1.05$

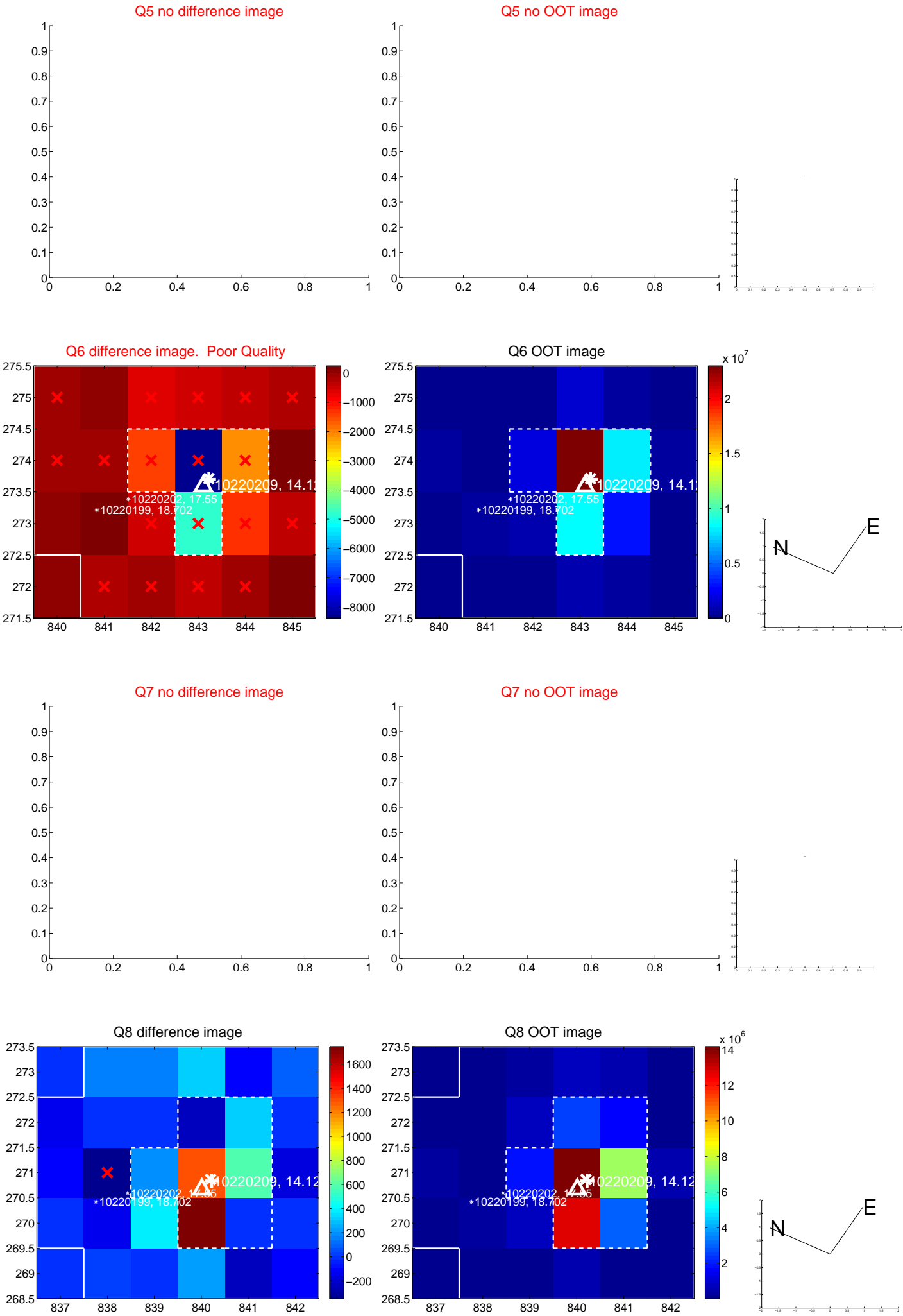


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets**; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: three- $\sigma$ . Red \*: target star. Blue \*: Other stars. Text next to a star gives its KIC ID and kepmag. KIC IDs > 15,000,000 are from the UKIRT catalog.

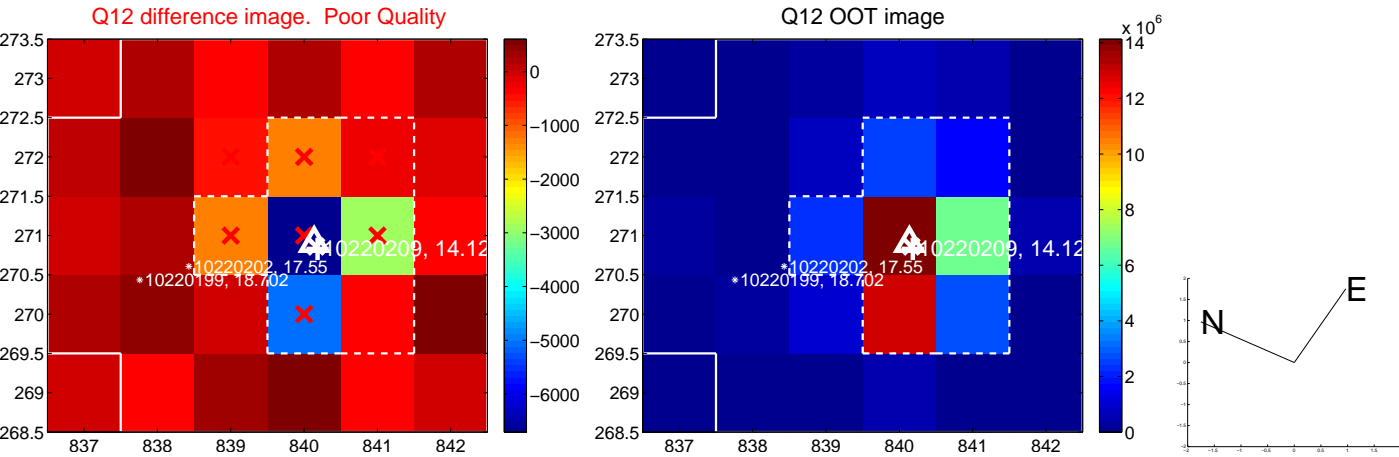
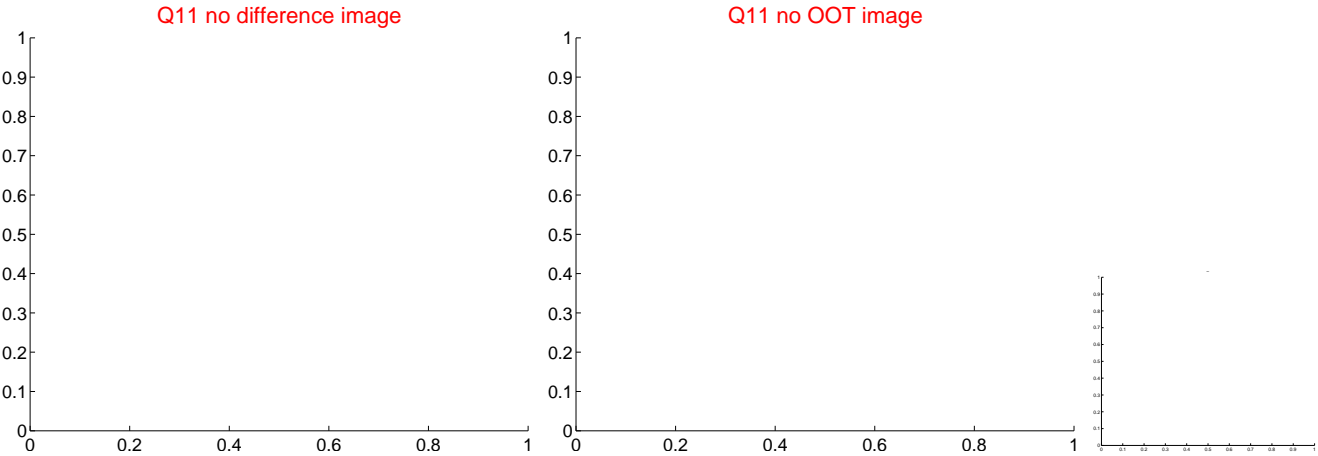
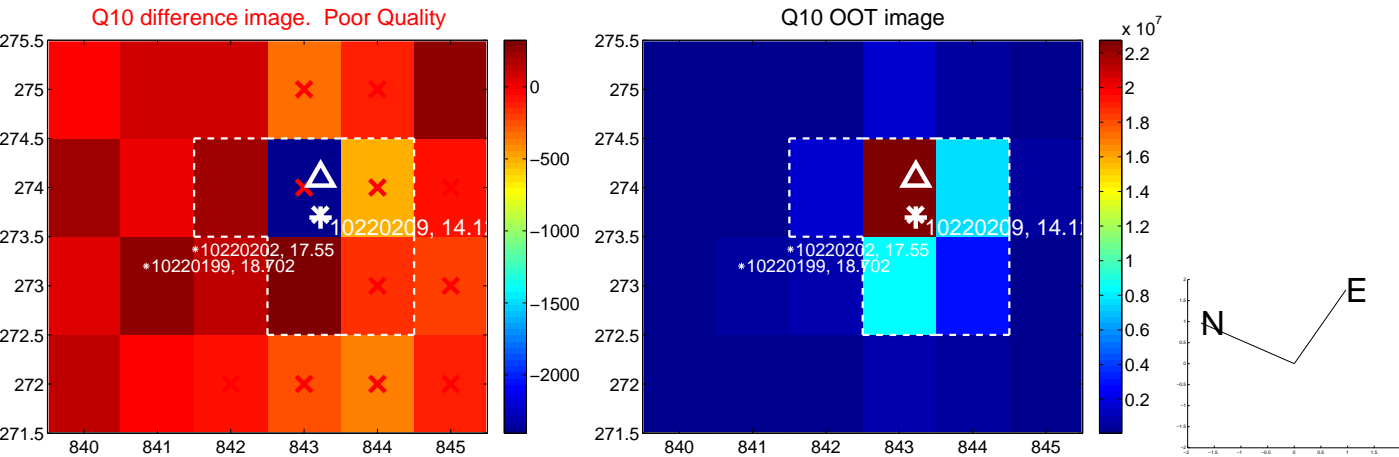
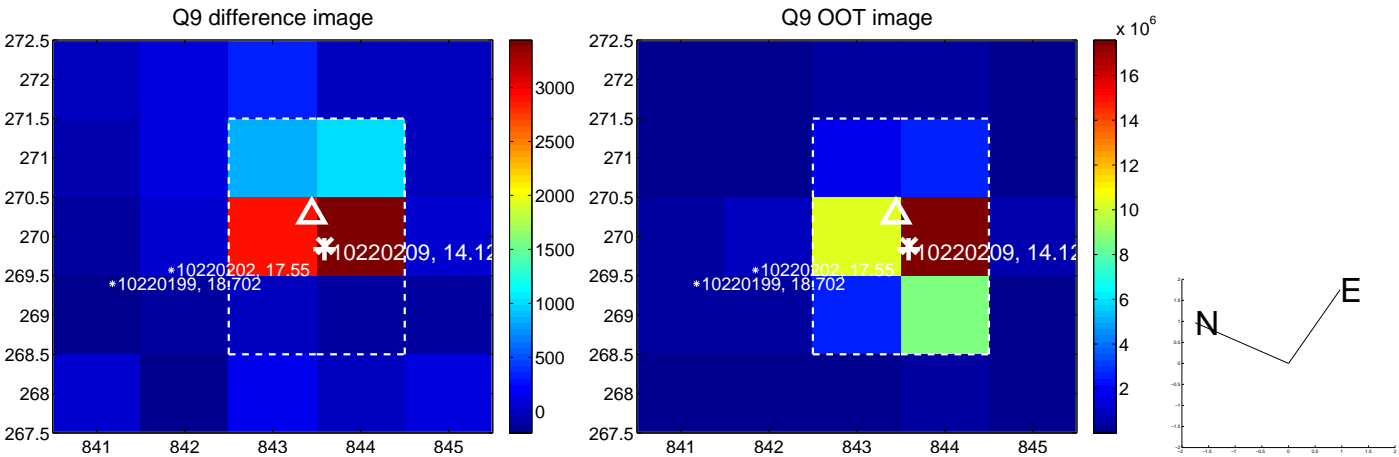
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value



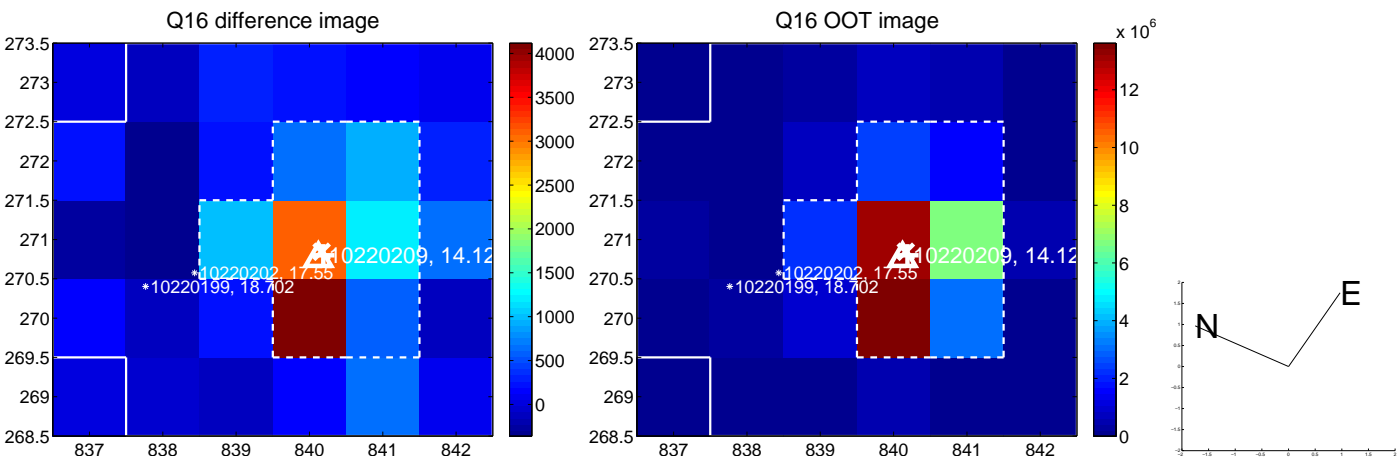
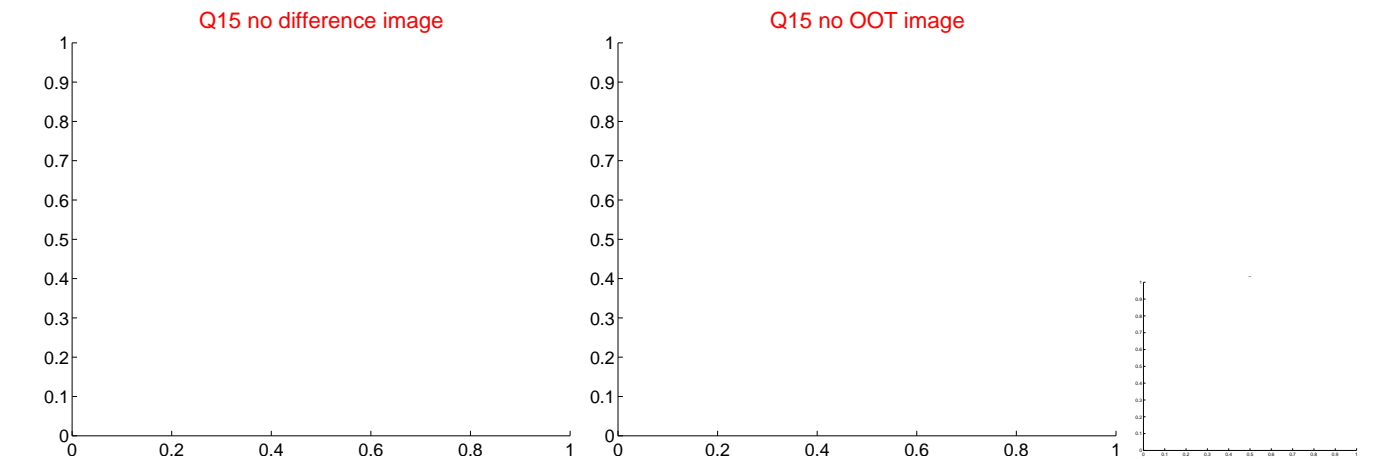
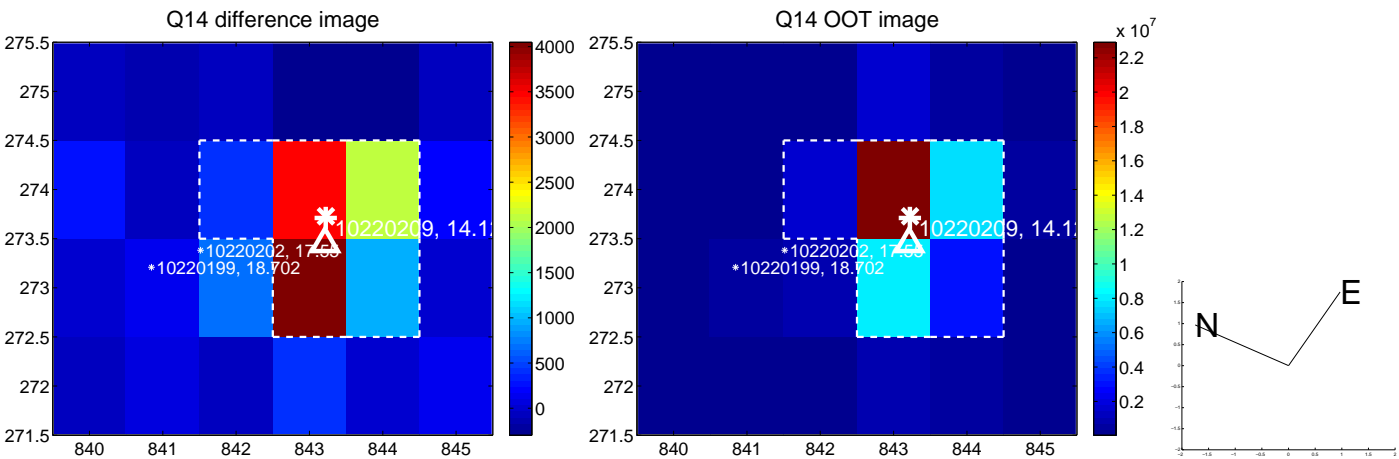
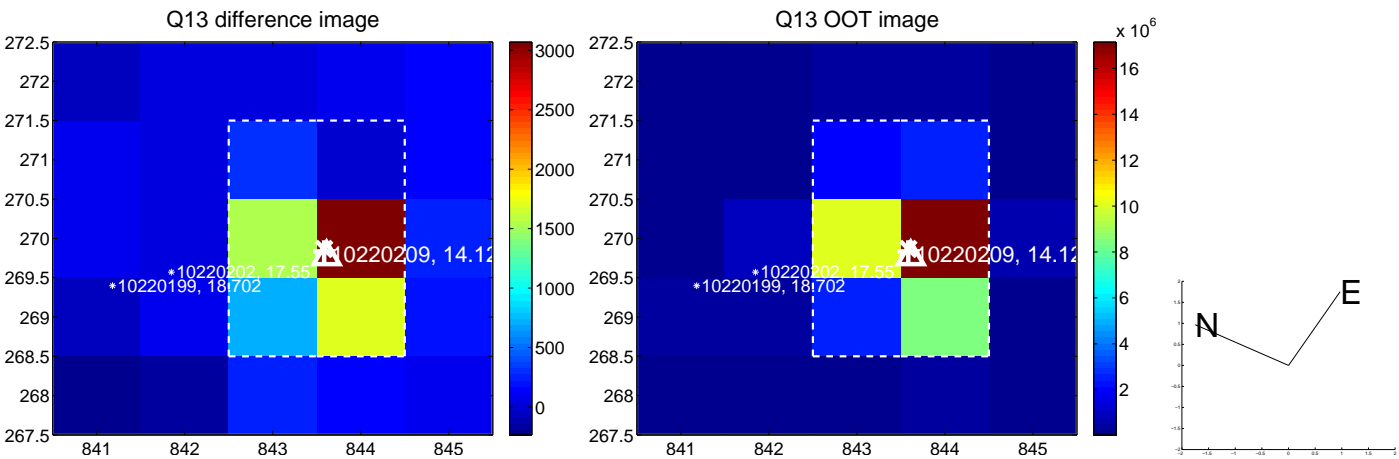
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

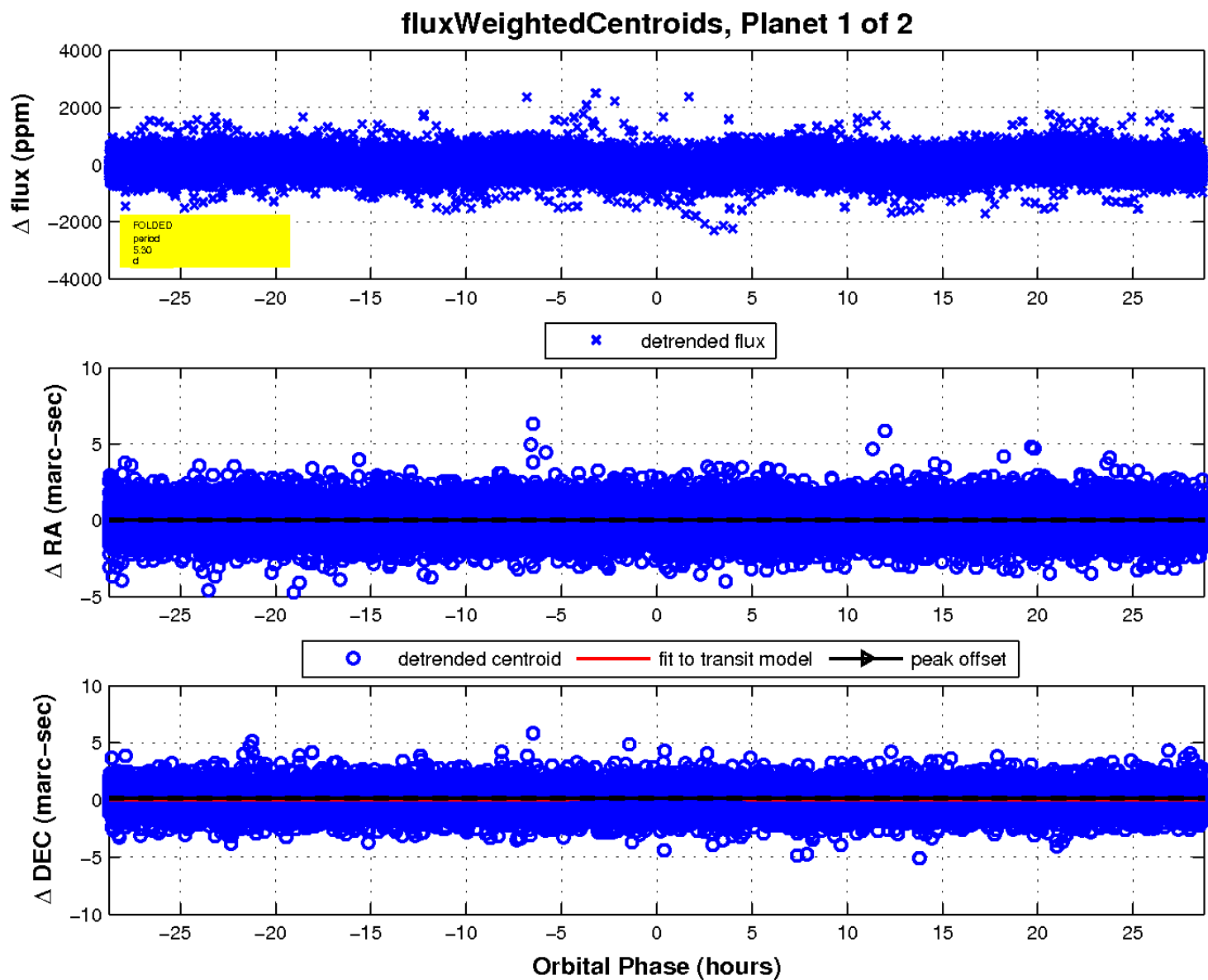
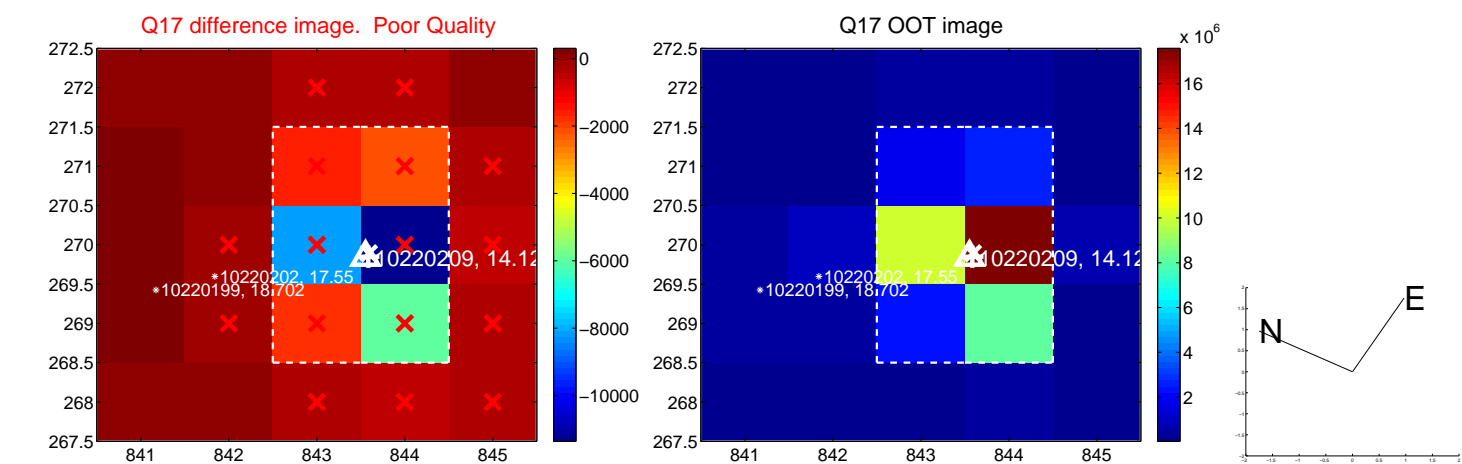


white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



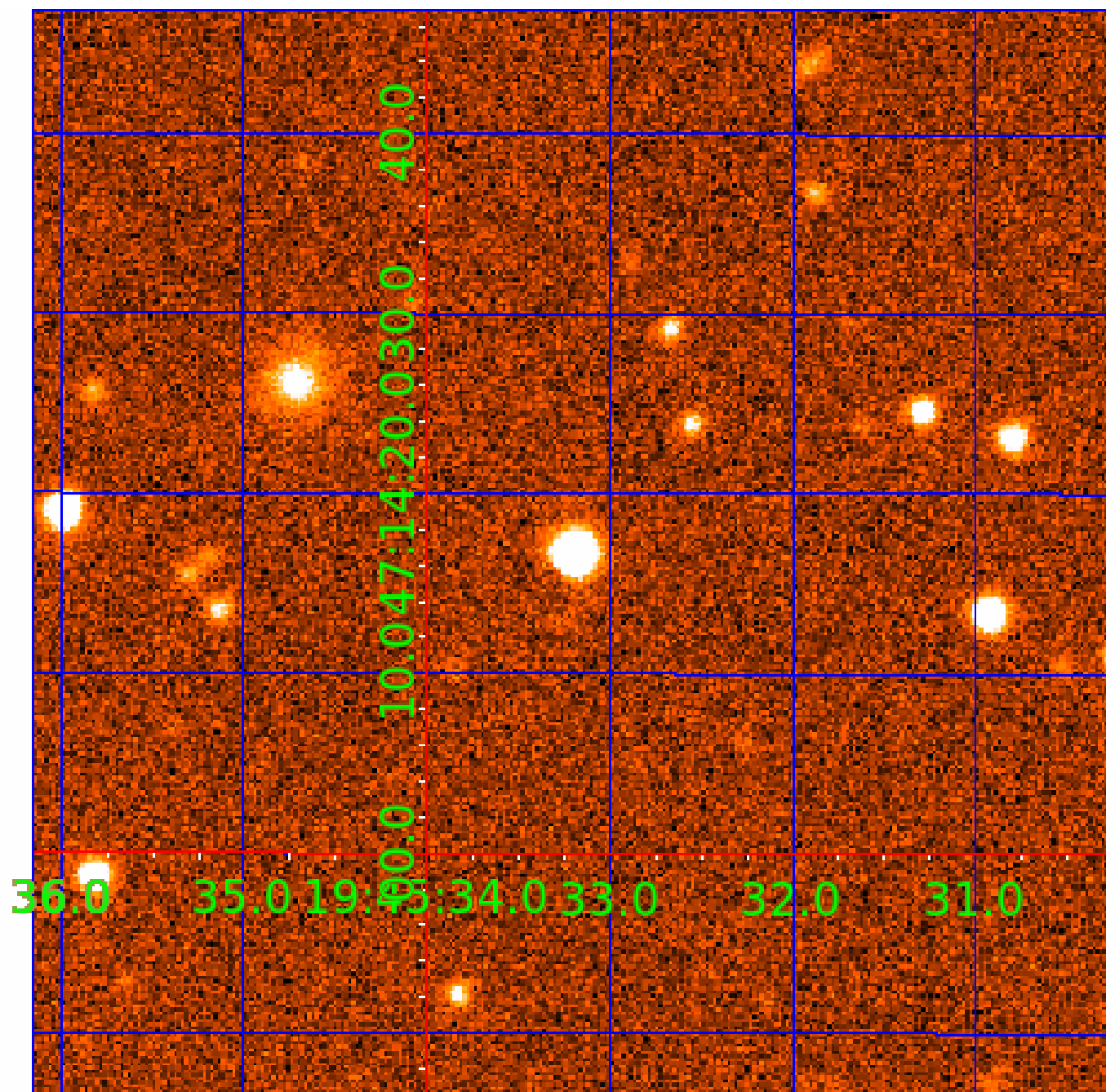


white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



UKIRT Image

Declination



# KIC 010220209

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
010220209-01	OBS	No	5.299195	132.672201	62.1	9.580	7.2	5.9	2.84	14652	2.50	44437.31
010220209-02	OBS	No	7.065052	132.176184	99.8	9.678	7.6	7.6	2.84	14652	3.21	30283.57

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
010220209-01	OBS	FP	0.00	1	0	0	0	LPP_DV—MOD_NONUNIQ_DV
010220209-02	OBS	FP	0.00	1	0	0	0	LPP_DV

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

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

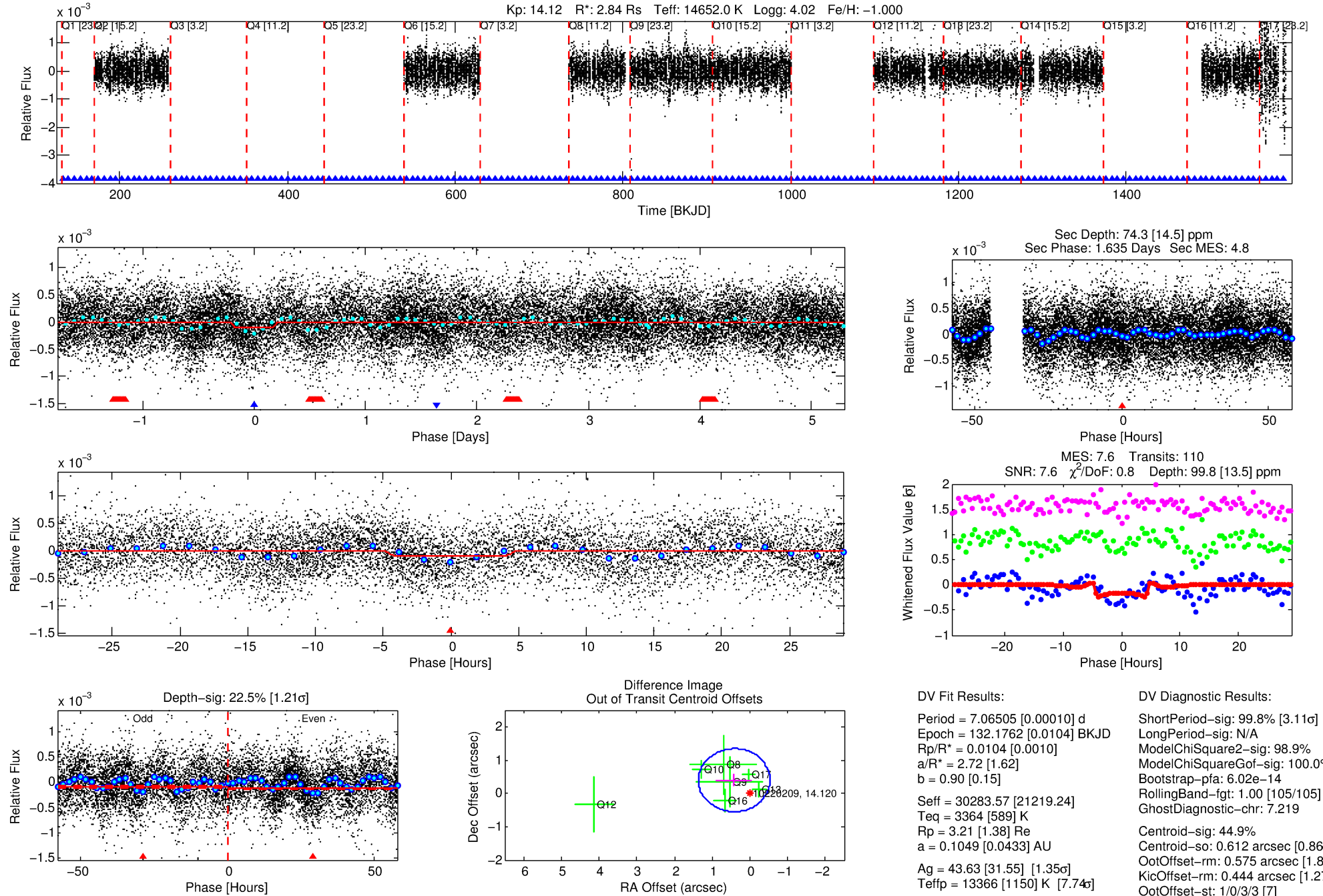
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 010220209-02

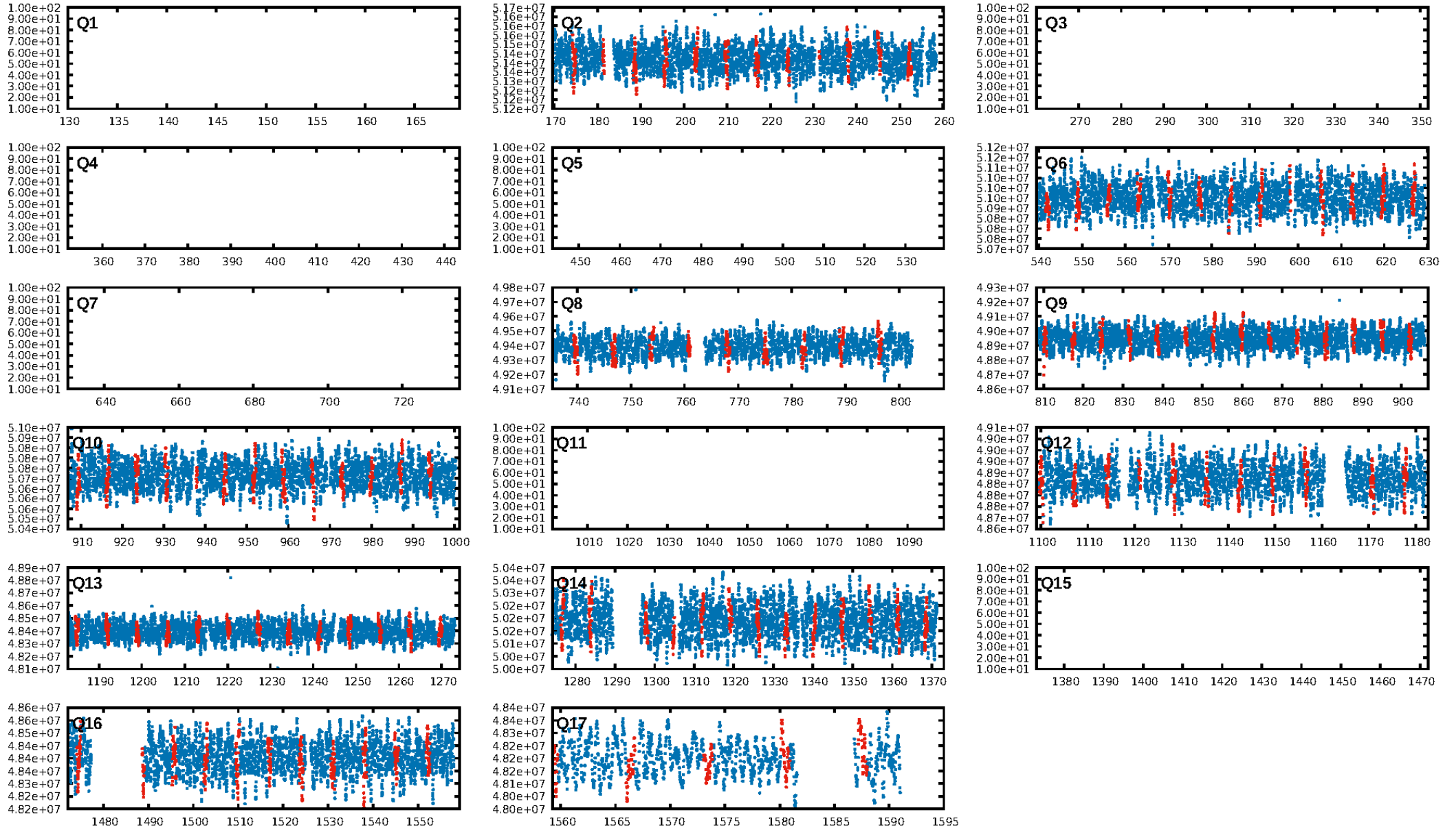
No Significant Match Found

# DV One-Page Summary

KIC: 10220209 Candidate: 2 of 2 Period: 7.065 d

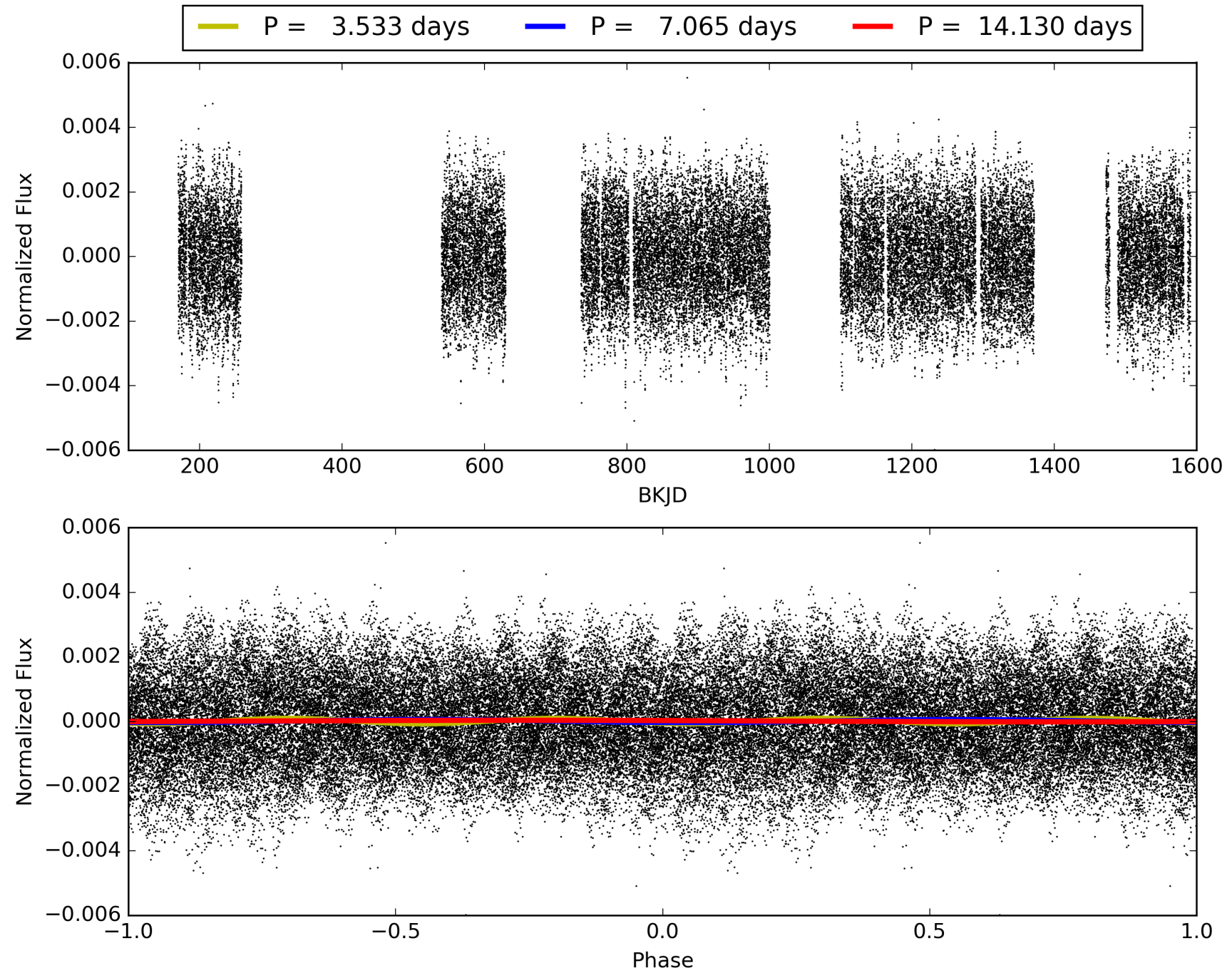


# TCE 010220209-02, PDC Light Curves



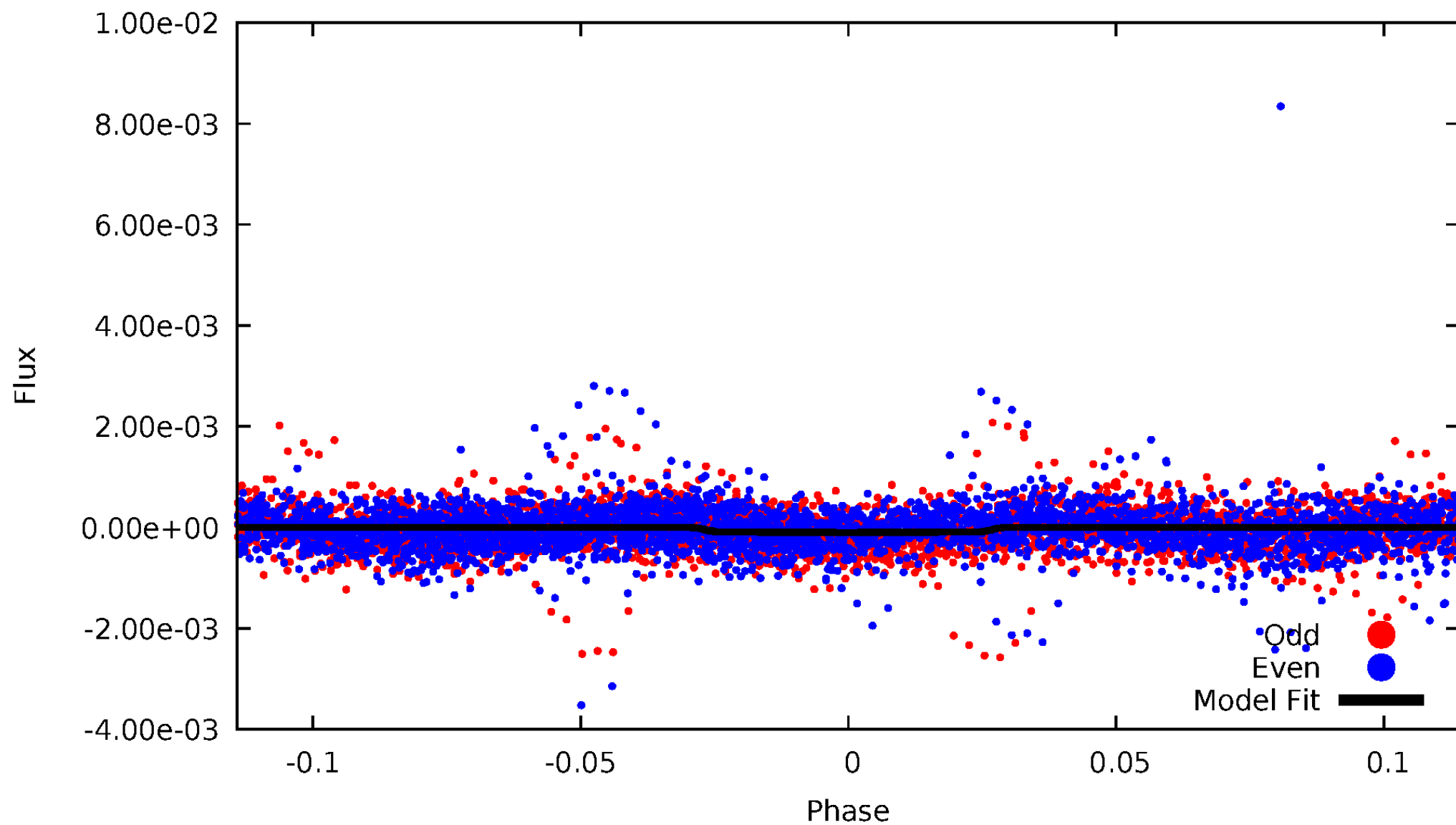


TCE 010220209-02



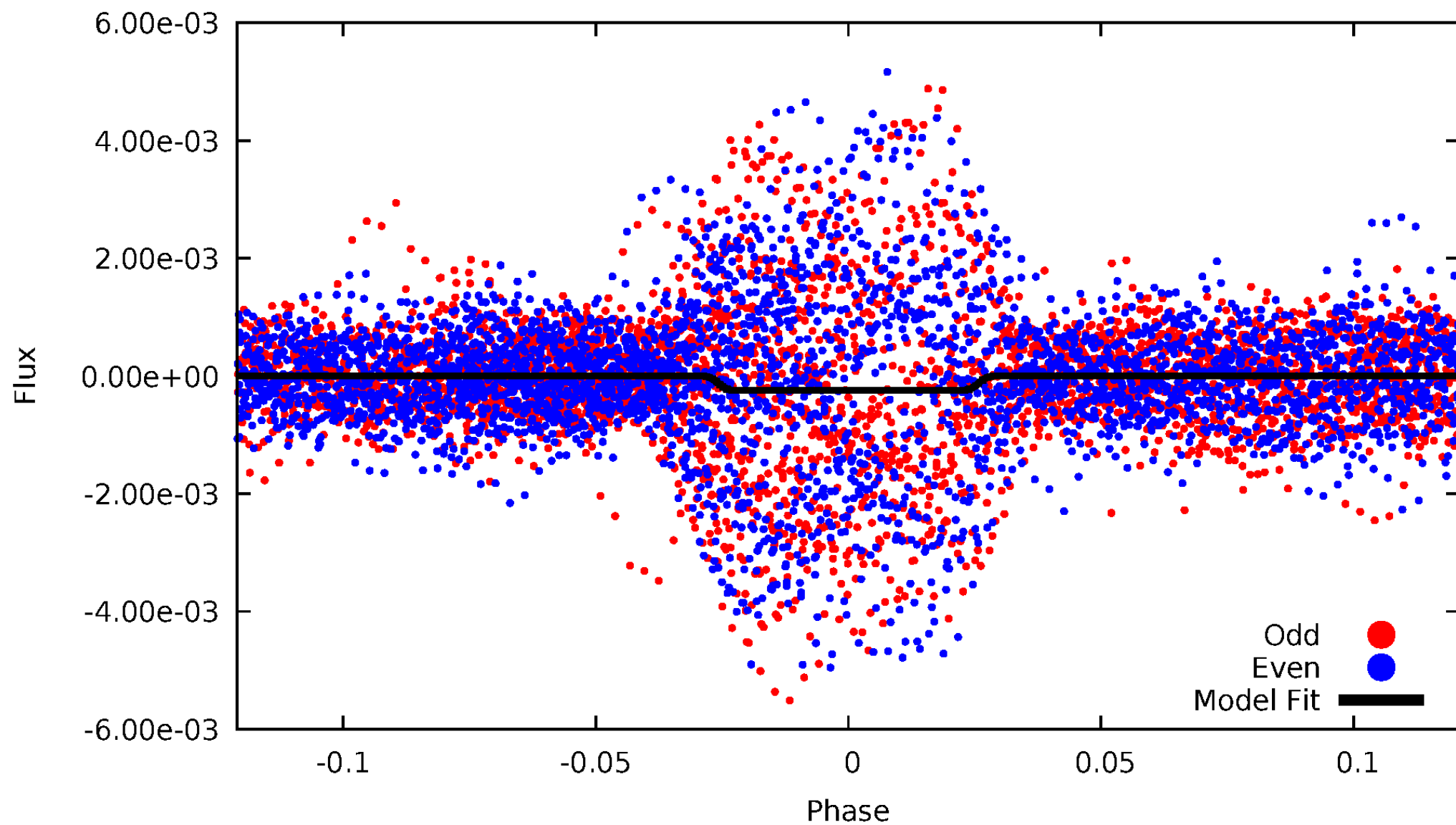
# DV Odd/Even

TCE 010220209-02



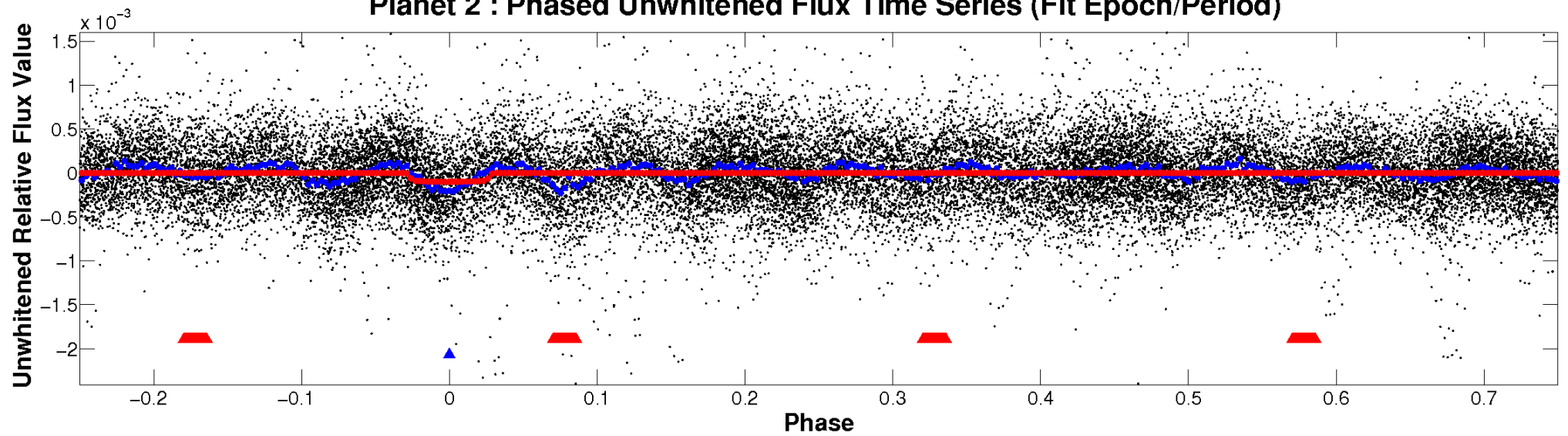
# ALT Odd/Even

TCE 010220209-02

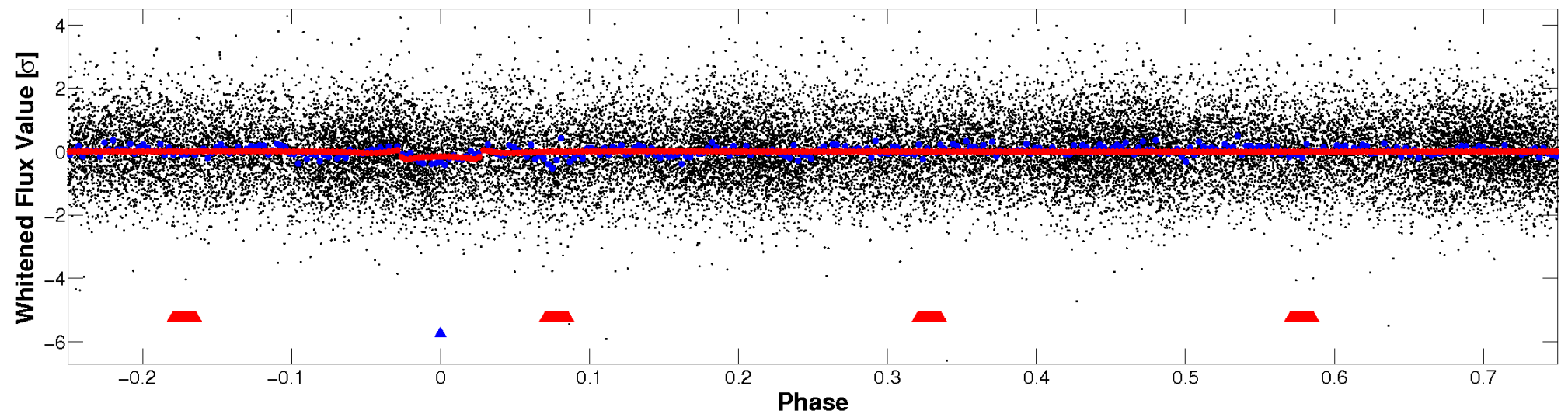


# Non-Whitened Vs. Whitened Light Curve

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

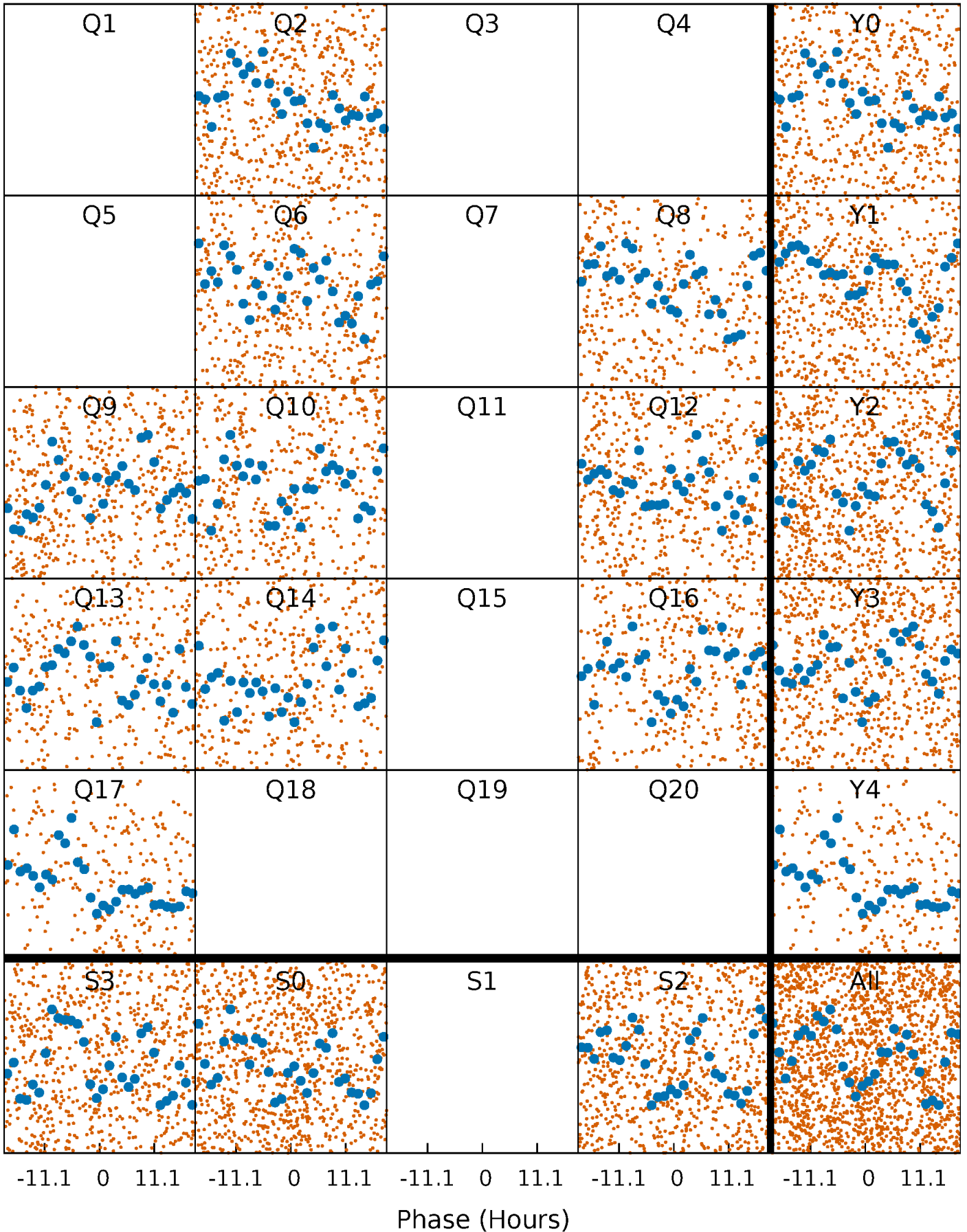


**Planet 2 : Phased Whitened Flux Time Series (Fit Epoch/Period)**



# PDC Quarter-Phased Transit Curves

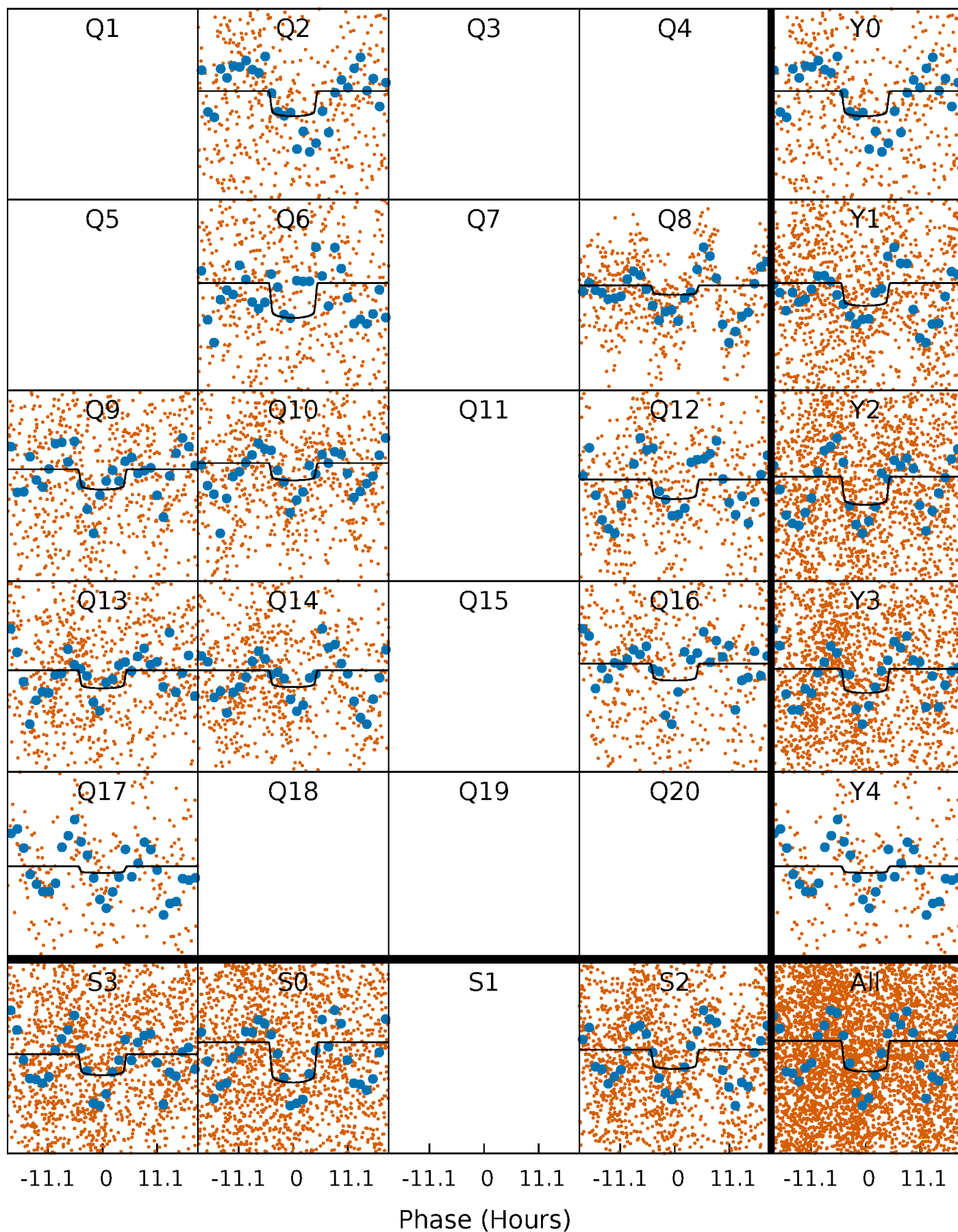
TCE 010220209-02   P= 7.065052 Days    $T_0=132.176184$  (BKJD)





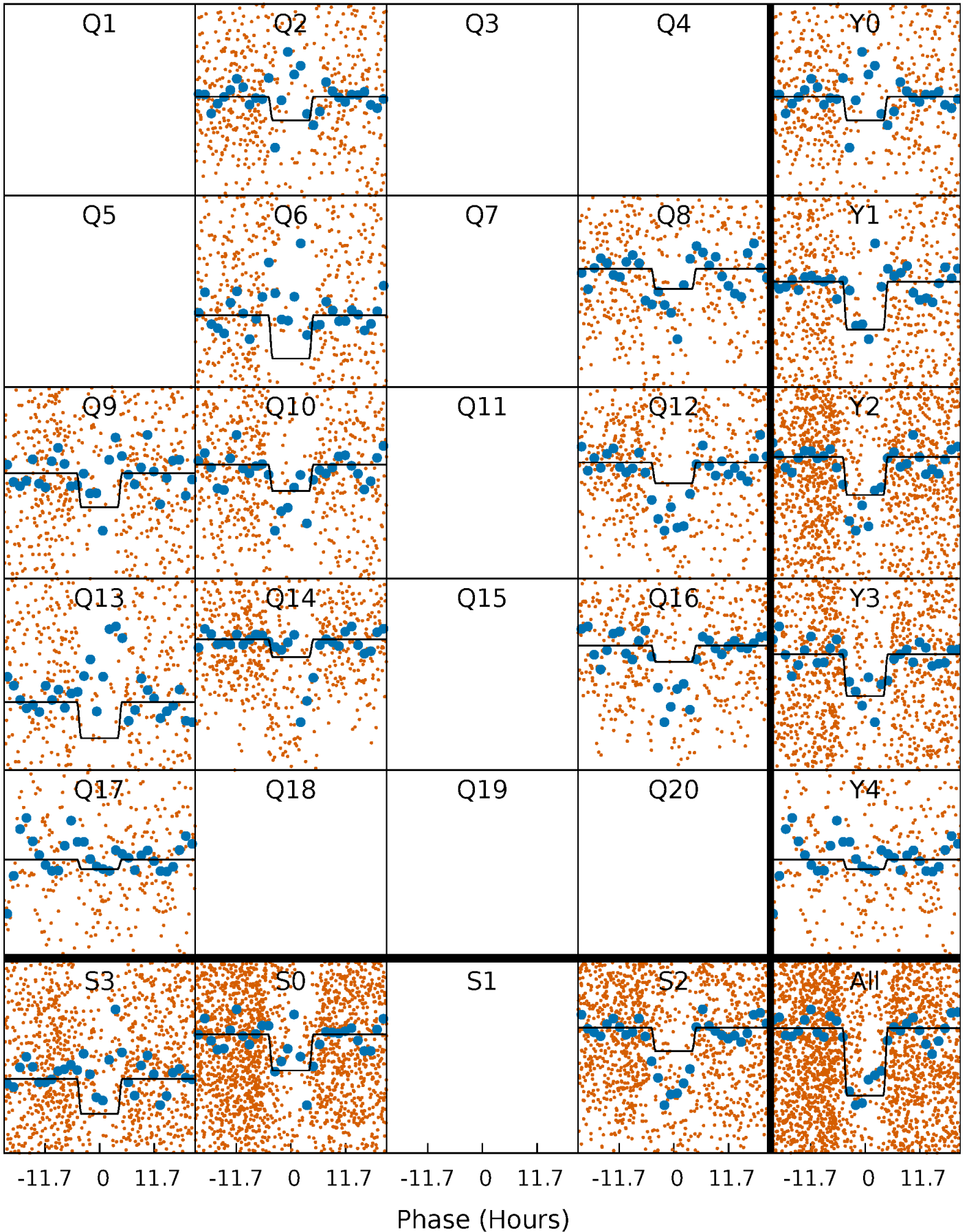
# DV Quarter-Phased Transit Curves

TCE 010220209-02   P= 7.065052 Days    $T_0=132.176184$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

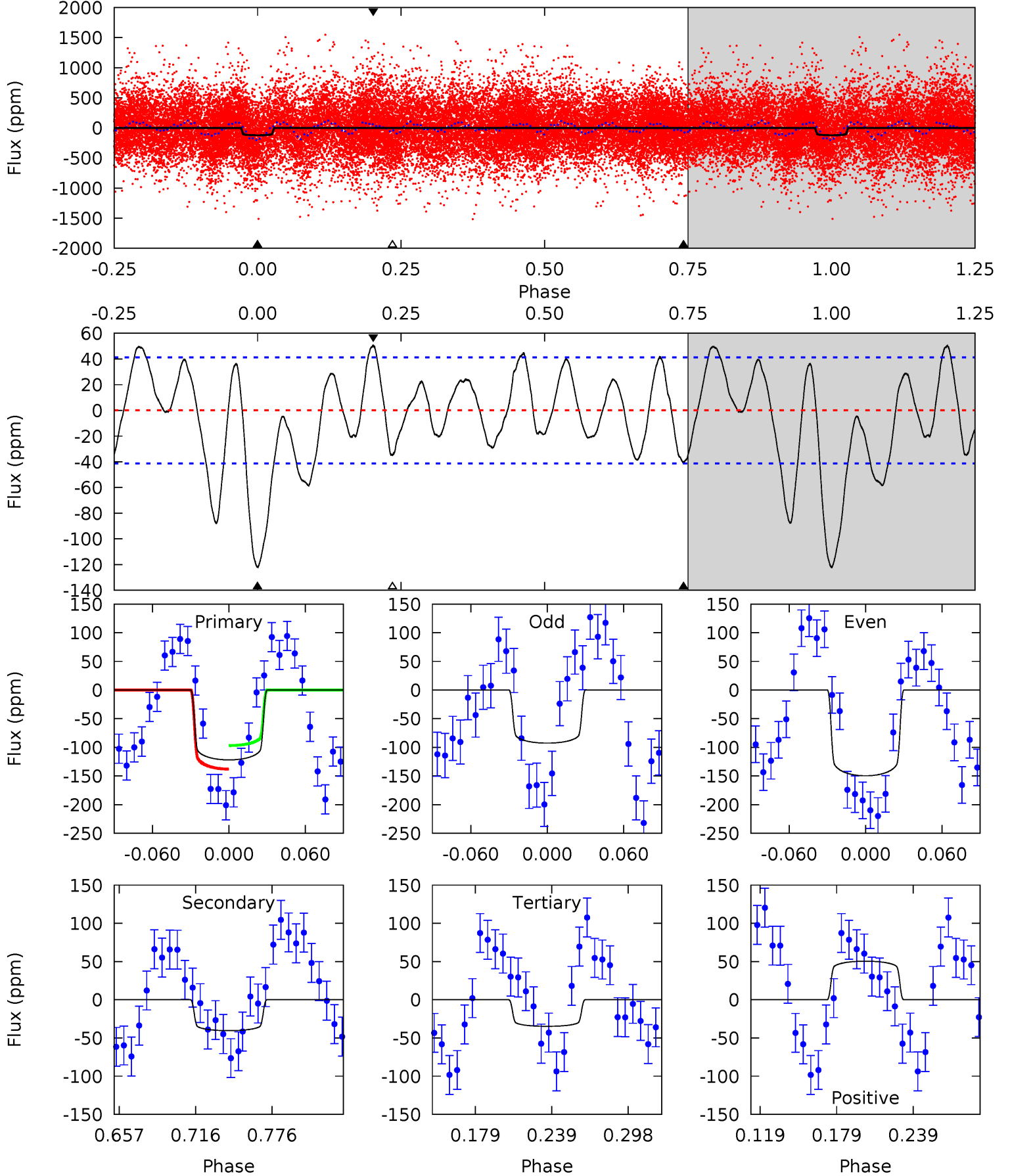
TCE 010220209-02    P= 7.064751 Days     $T_0=132.191644$  (BKJD)



# DV Model-Shift Uniqueness Test

010220209-02, P = 7.065052 Days, E = 132.176184 Days

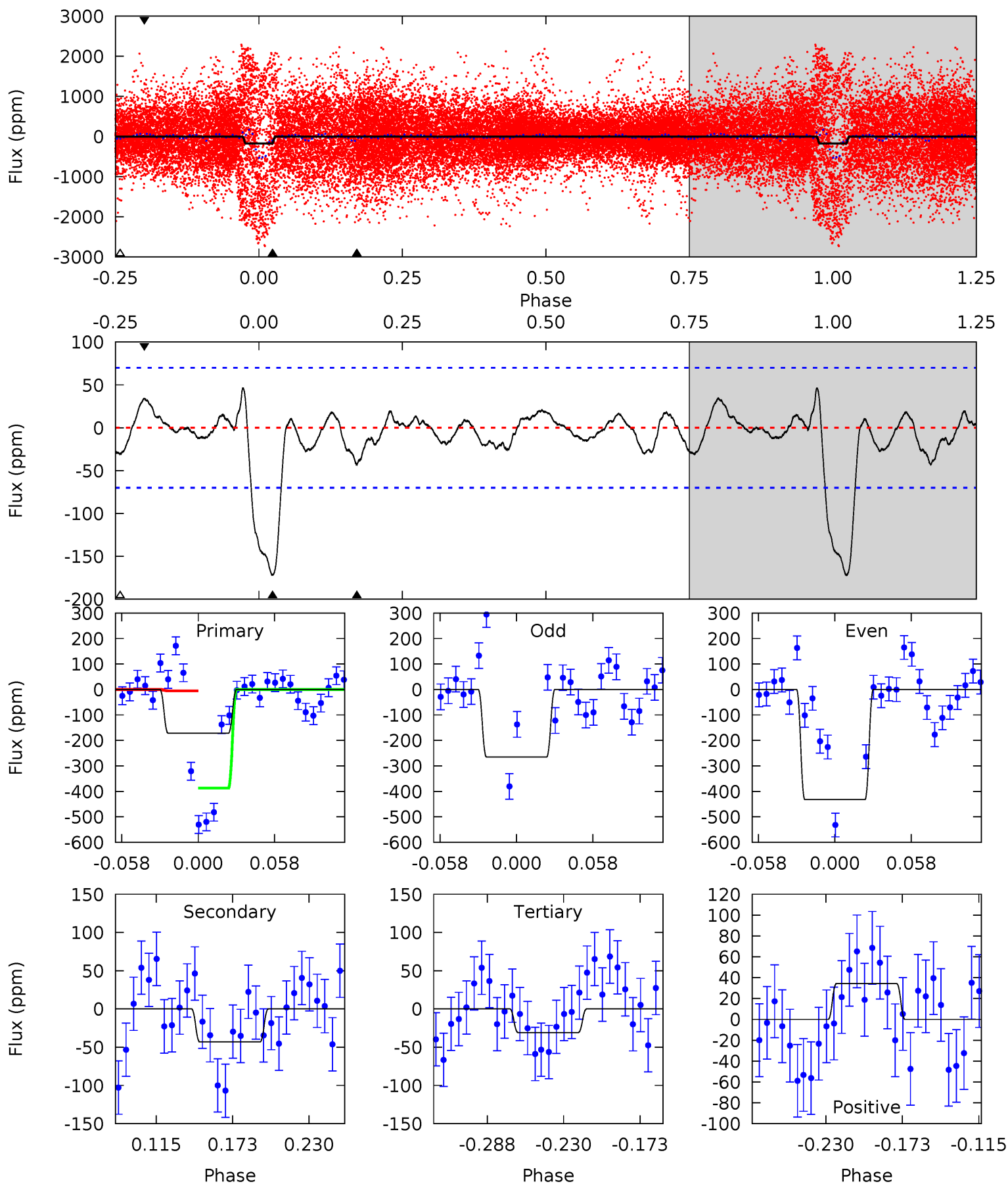
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
13.8	4.57	3.94	5.71	4.67	1.88	3.26	9.87	8.09	0.64	-1.14	3.27	1.12	0.29	2.31



# Alt Model-Shift Uniqueness Test

010220209-02, P = 7.064751 Days, E = 132.191644 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
11.5	2.89	2.07	2.29	4.68	1.90	0.96	9.43	9.20	0.82	0.59	5.30	1.95	0.21	11.2



### Stellar Parameters For KIC 010220209

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R (R_{\odot})$	$M(M_{\odot})$	$p_{\star} (g \cdot \text{cm}^{-3})$
	$14652^{+344}_{-762}$	$4.020^{+0.396}_{-0.008}$	$-1.000^{+0.300}_{-0.300}$	$2.840^{+0.041}_{-1.191}$	$3.080^{+-1.000}_{-0.528}$	$0.189^{+0.632}_{-0.005}$
	+2%/-5%	+10%/-0%	+30%/-30%	+1%/-42%	+32%/-17%	+334%/-3%
Source	KIC0	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 010220209-02 / KOI

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{max} (K)$	$T_{obs} (K)$	$A_{obs}$
DV	$-40 \pm 9$	$2.96^{+0.40}_{-0.64}$	$4475^{+272}_{-475}$	$9707^{+1047}_{-1009}$	$29^{+16}_{-9}$
Alt.	$-43 \pm 15$	$4.52^{+0.49}_{-0.93}$	$4487^{+263}_{-459}$	$7494^{+866}_{-857}$	$13^{+8}_{-5}$

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

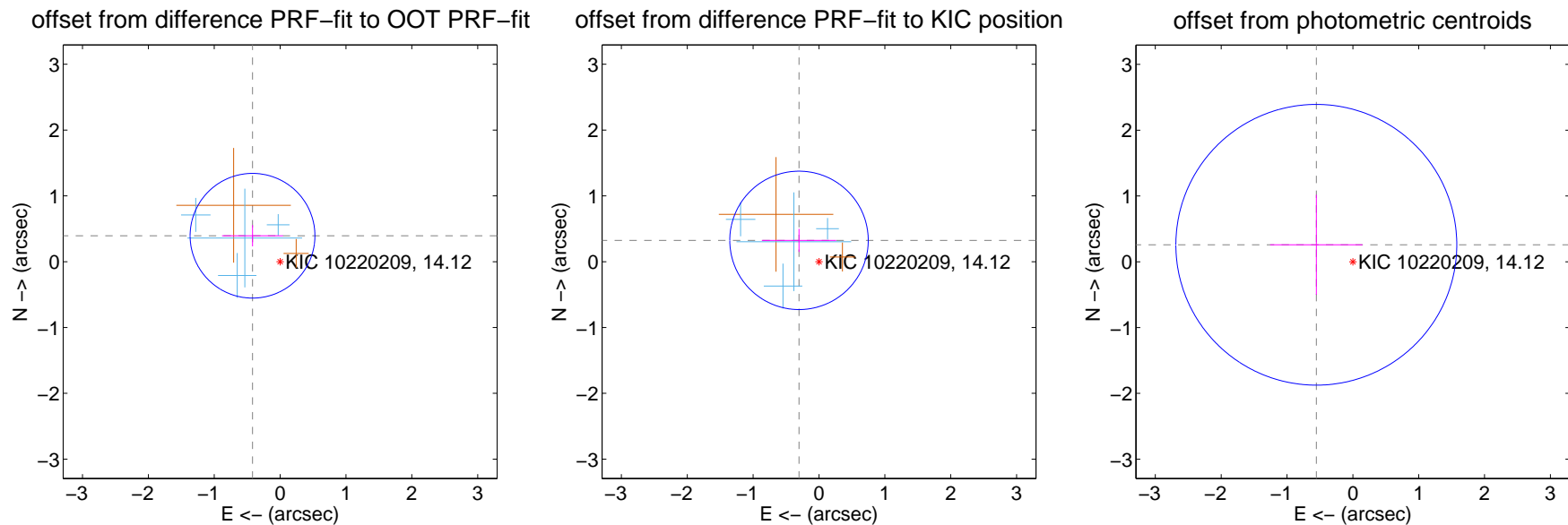
## DV Centroid Data

Supplemental centroid analysis for 010220209-02. Kepler magnitude: 14.12. Transit SNR 7.57

There are 4 quarters with good PRF difference image offsets

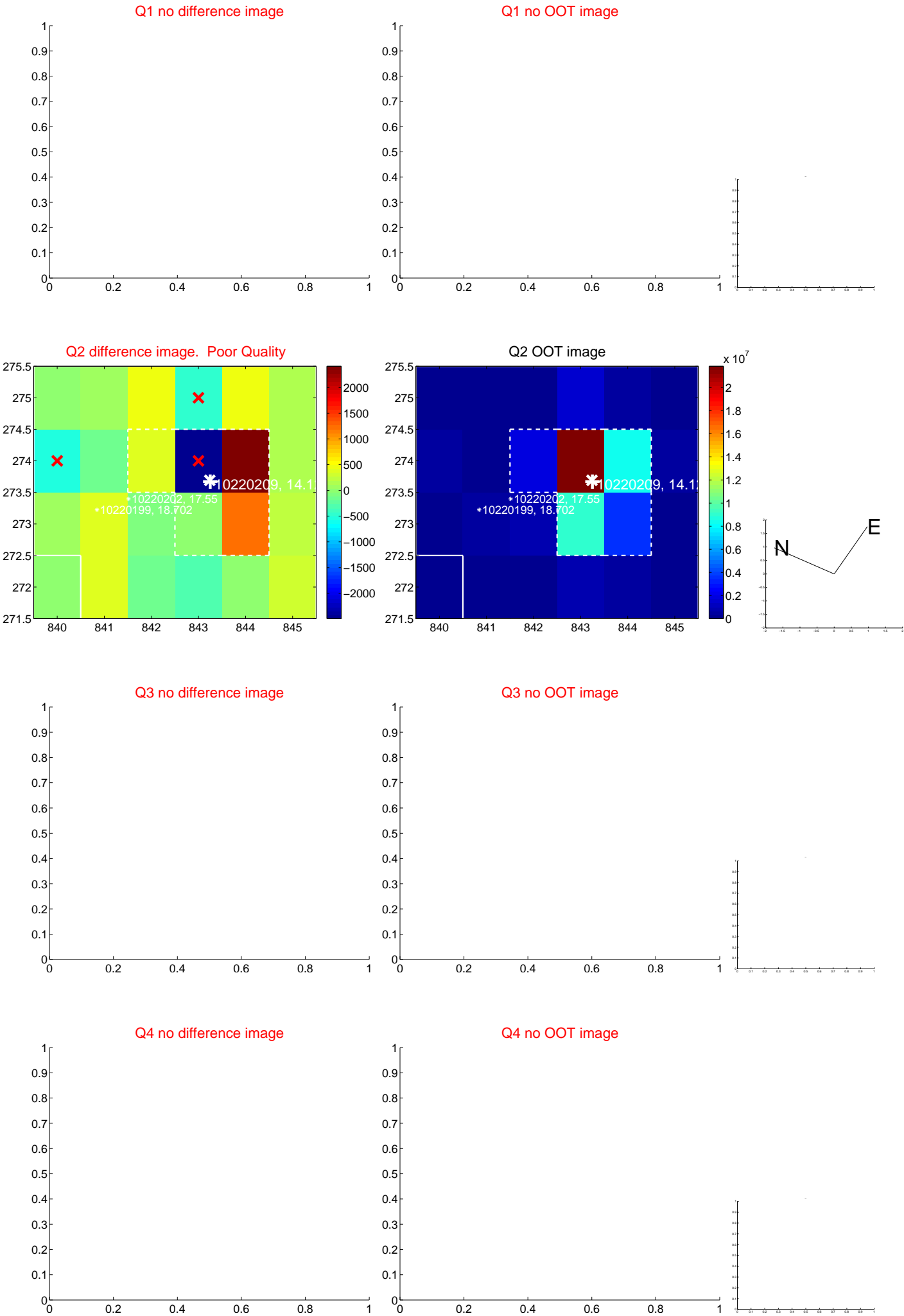
The direct PRF centroid is offset from the target star catalog position by about 0.17 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.575 \pm 0.316$	1.82	$0.419 \pm 0.463$	$0.394 \pm 0.161$
PRF-fit source offset from KIC position	$0.444 \pm 0.350$	1.27	$0.303 \pm 0.564$	$0.324 \pm 0.176$
photometric centroid source offset	$0.61 \pm 0.71$	0.86	$0.55 \pm 0.70$	$0.26 \pm 0.76$



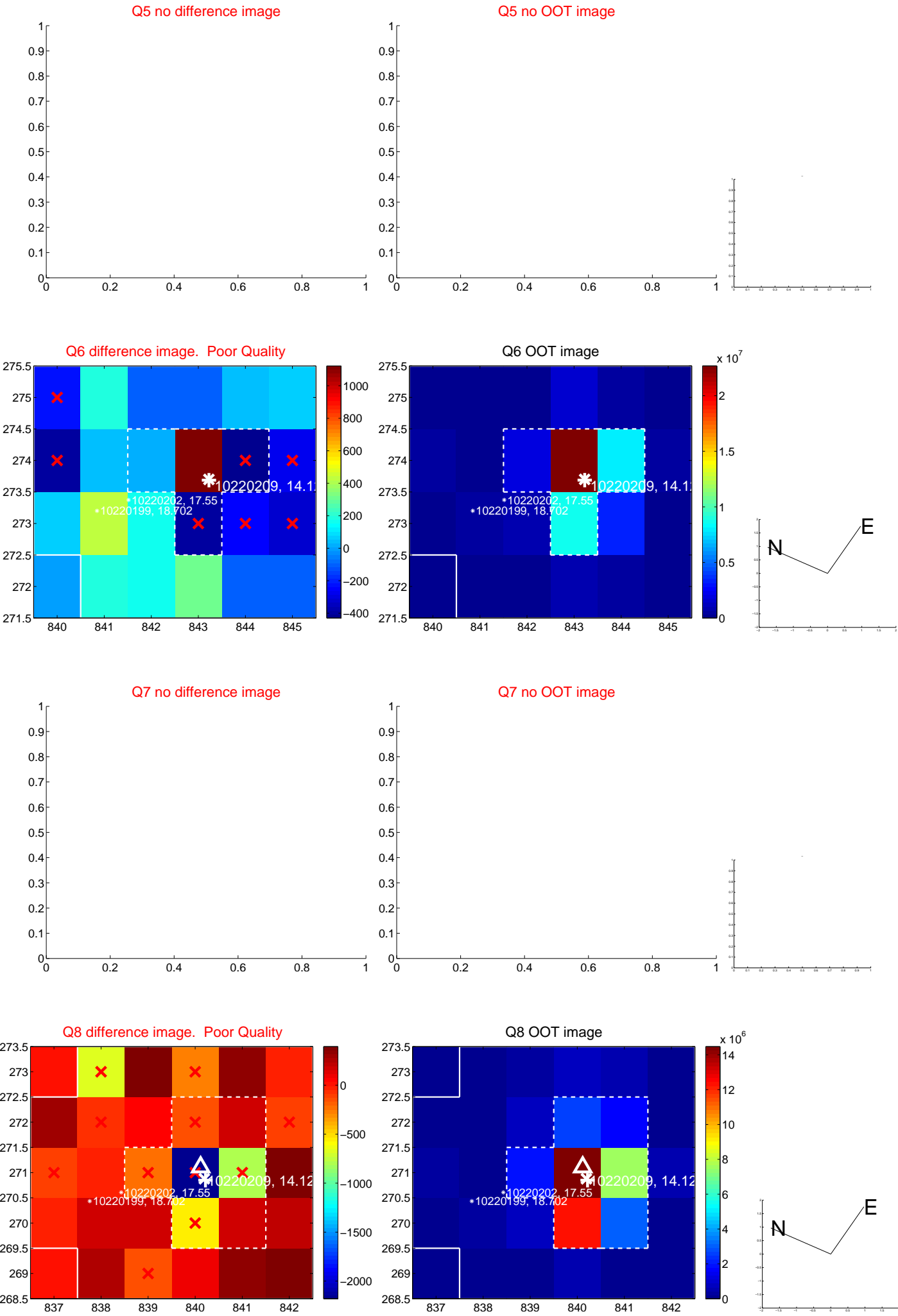
Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets**; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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

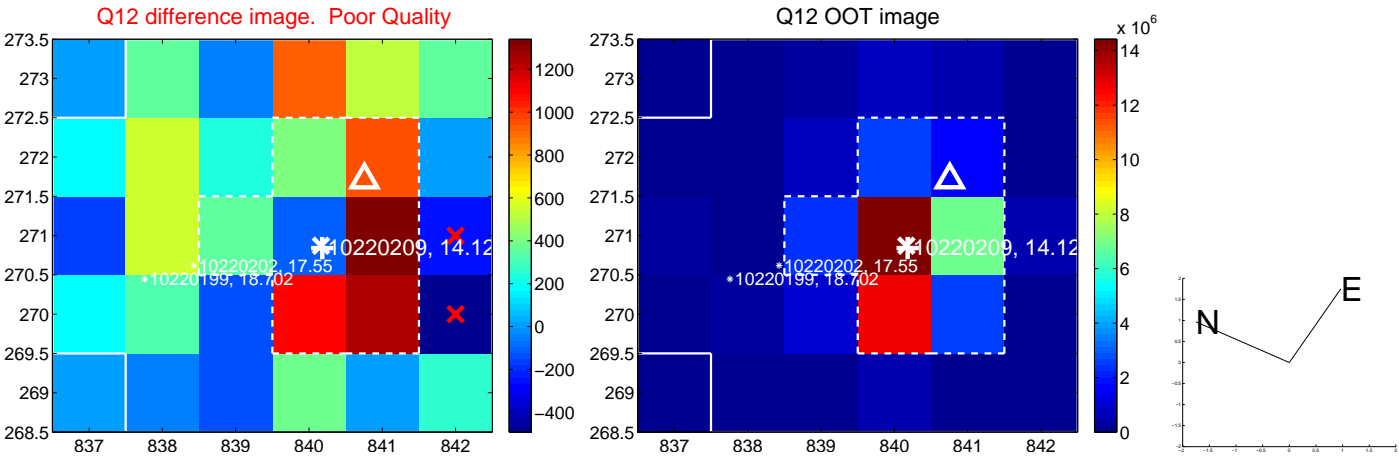
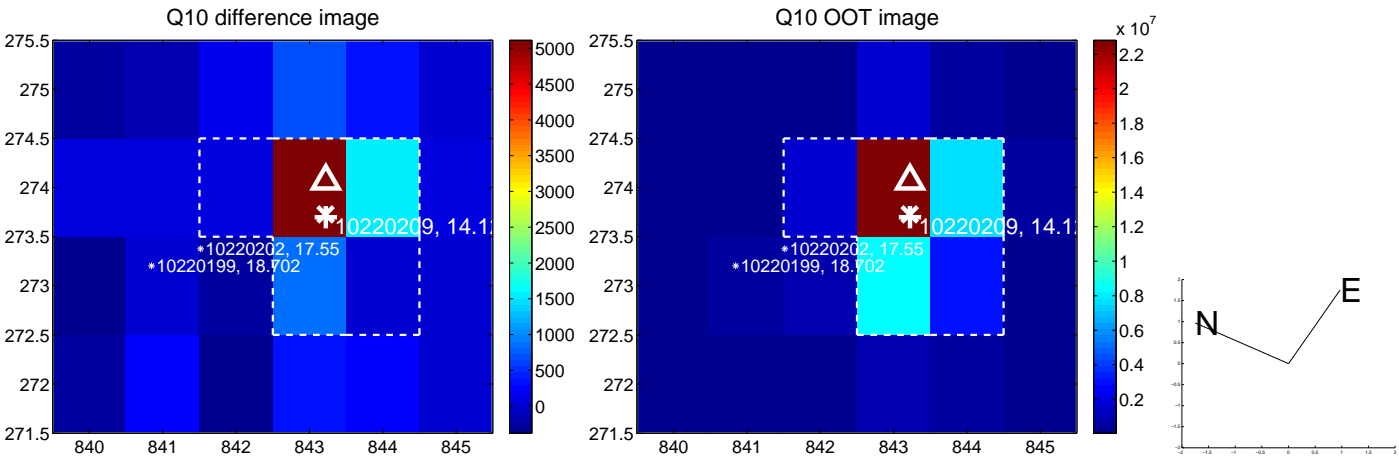
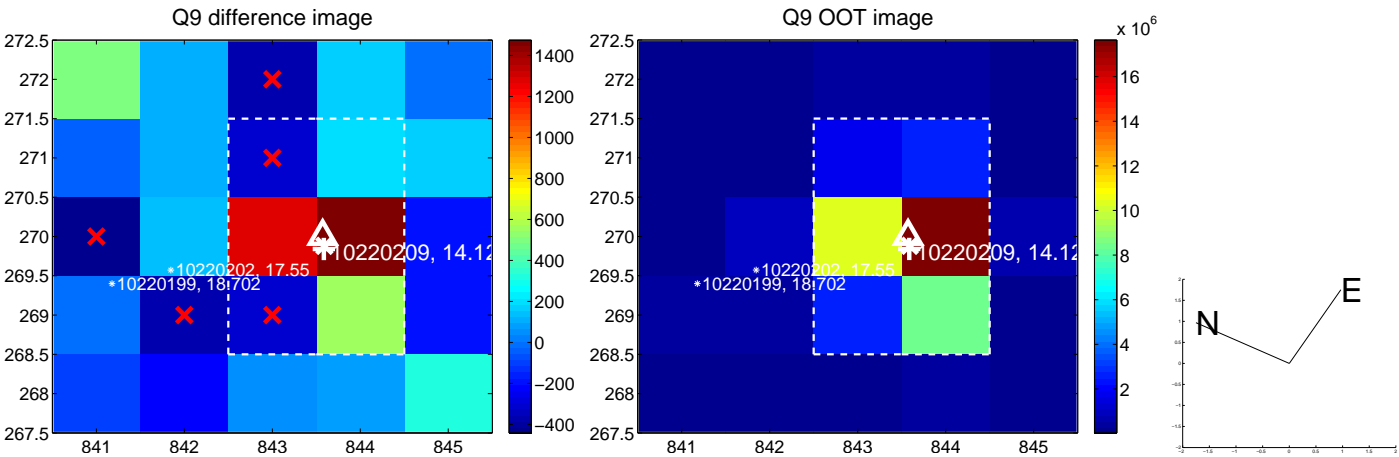




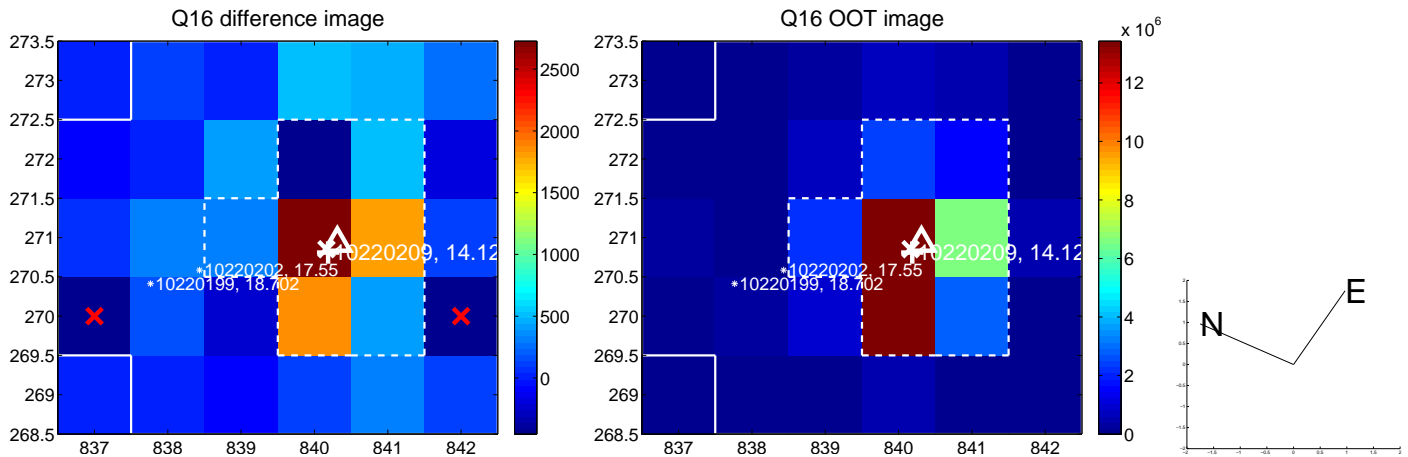
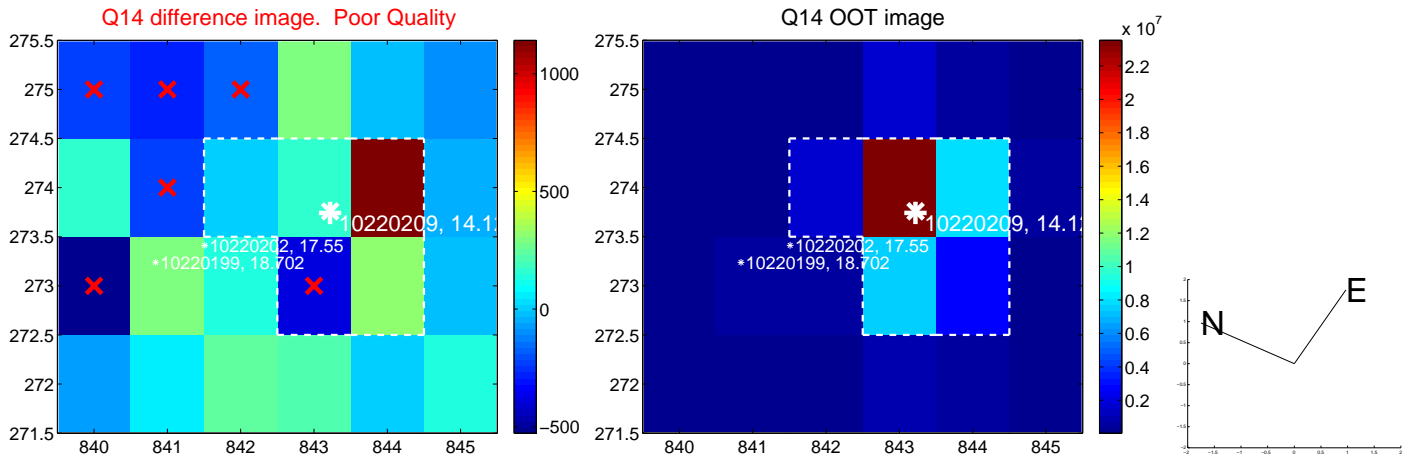
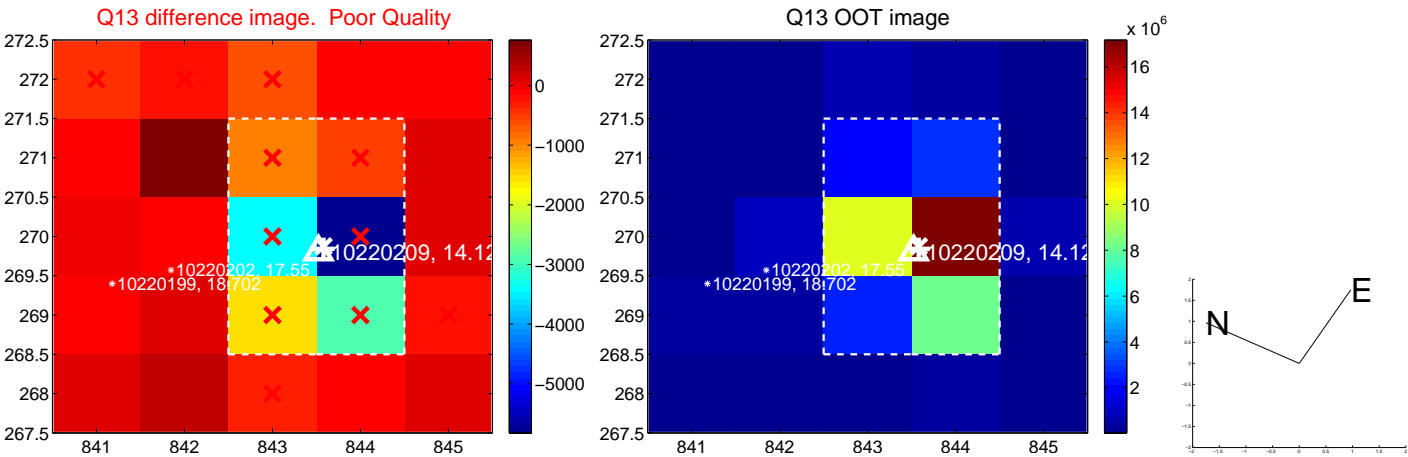
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



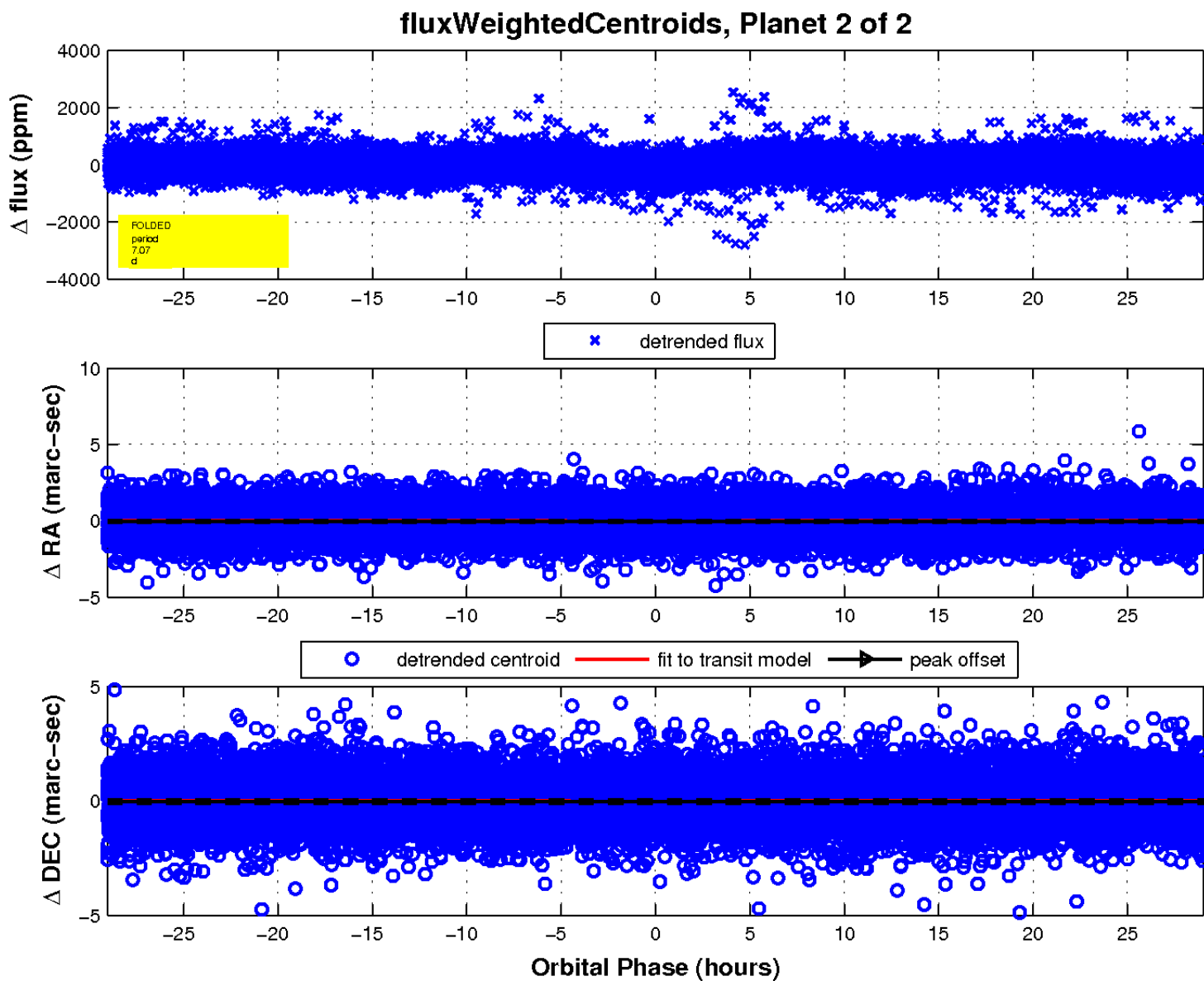
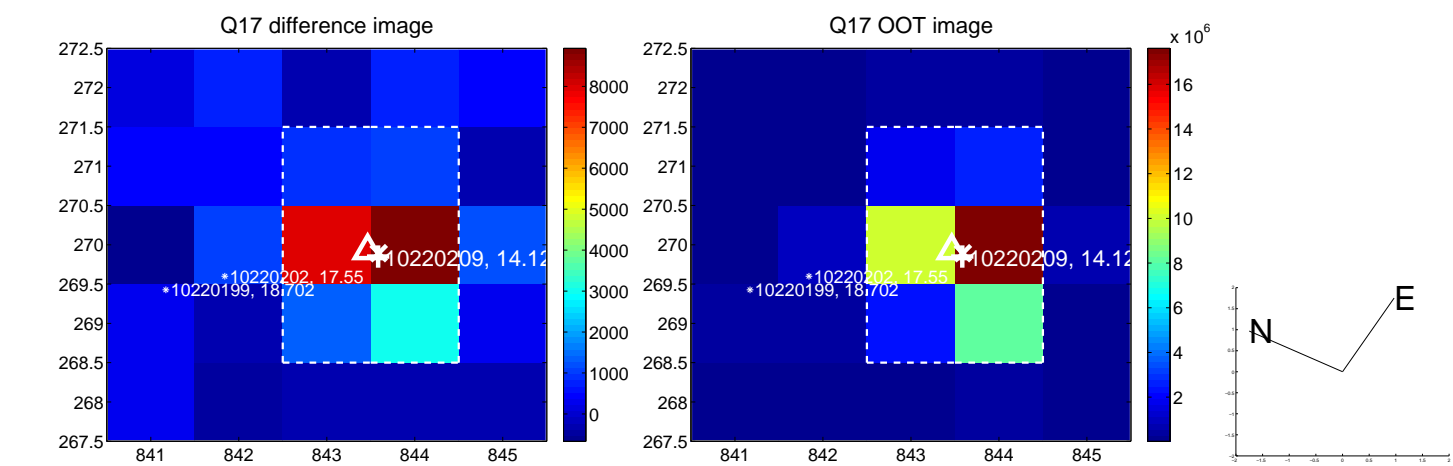
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

