

# KIC 002987160

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
002987160-02	OBS	No	331.764796	337.580356	1005.9	3.607	12.8	4.2	0.84	5551	2.66	0.84
002987160-03	OBS	No	395.979225	341.823625	1598.6	10.272	12.0	4.6	0.84	5551	3.34	0.66
002987160-04	OBS	No	369.254809	411.997279	1340.3	2.953	13.8	6.7	0.84	5551	3.17	0.73
002987160-05	OBS	No	349.223163	284.990869	1051.3	6.000	12.5	-1.0	0.84	5551	2.71	0.79

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
002987160-02	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_CHASES_MARSHALL_SKYE—LPP_DV—ALL_TRANS_CHASES—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV—INCONSISTENT_TRANS—CENT_FEW_DIFFS
002987160-03	OBS	FP	0.00	1	0	1	0	LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV—INCONSISTENT_TRANS—CENT_FEW_DIFFS—HALO_GHOST
002987160-04	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_CHASES_MARSHALL—LPP_DV—LPP_ALT—ALL_TRANS_CHASES—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV—CENT_FEW_DIFFS
002987160-05	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_CHASES—LPP_DV—LPP_ALT—ALL_TRANS_CHASES—INCONSISTENT_TRANS—CENT_NOFITS

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

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

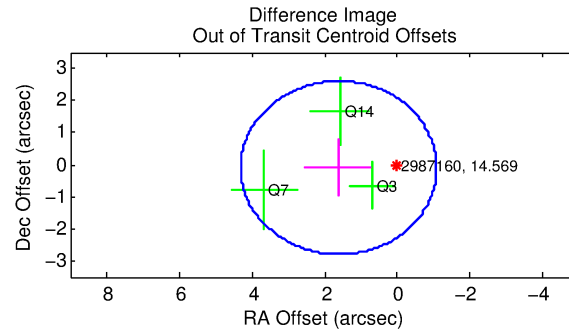
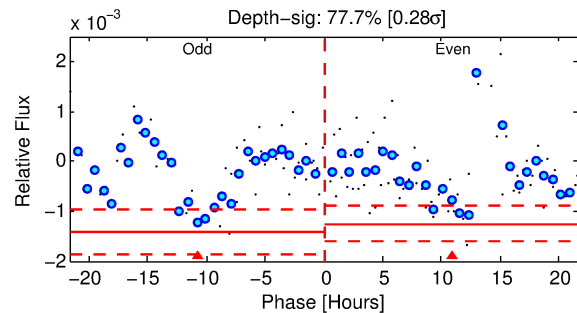
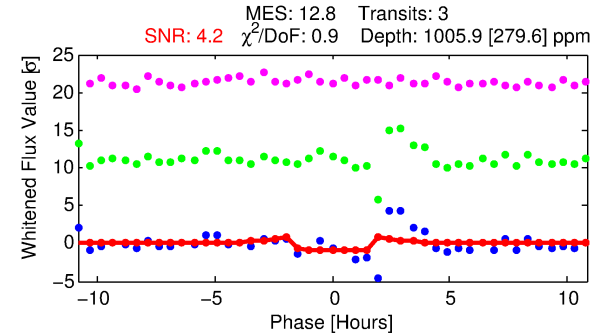
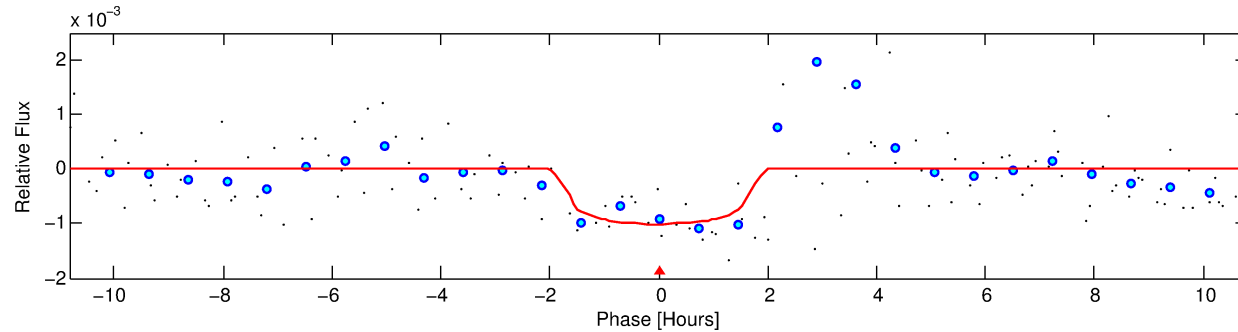
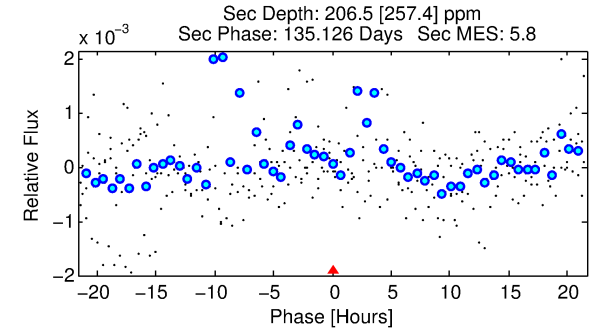
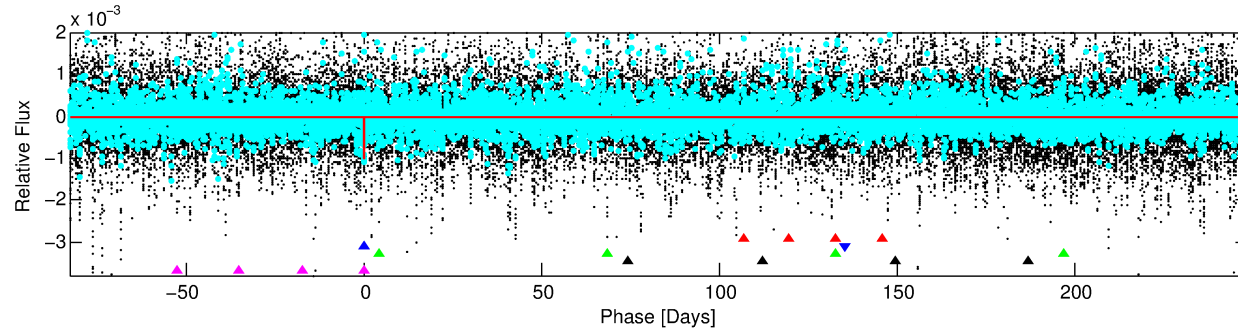
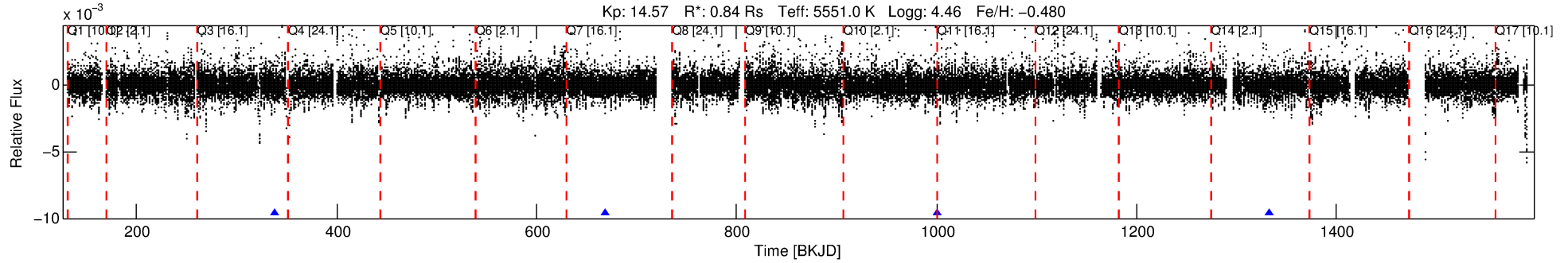
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 002987160-02

No Significant Match Found

# DV One-Page Summary

KIC: 2987160 Candidate: 2 of 5 Period: 331.765 d



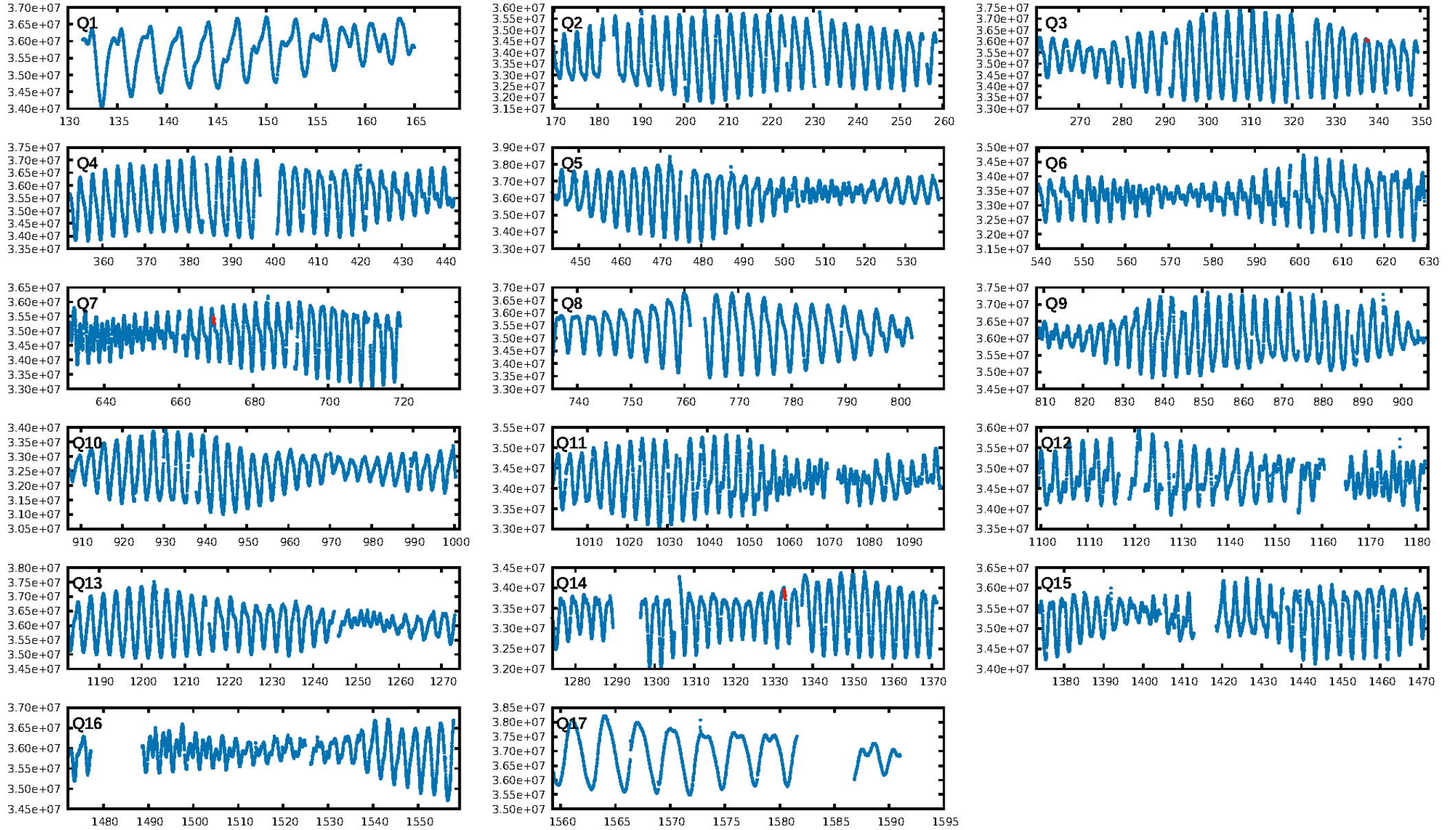
## DV Fit Results:

Period = 331.76480 [0.00512] d  
Epoch = 337.5804 [0.0108] BKJD  
Rp/R\* = 0.0289 [0.0709]  
a/R\* = 715.38 [7695.14]  
b = 0.15 [71.65]  
Seff = 0.84 [0.29]  
Teq = 244 [21] K  
Rp = 2.66 [6.55] Re  
a = 0.8488 [0.1720] AU  
Ag = 11584.05 [58815.82] [0.20 $\sigma$ ]  
Teffp = 3917 [4963] K [0.74 $\sigma$ ]

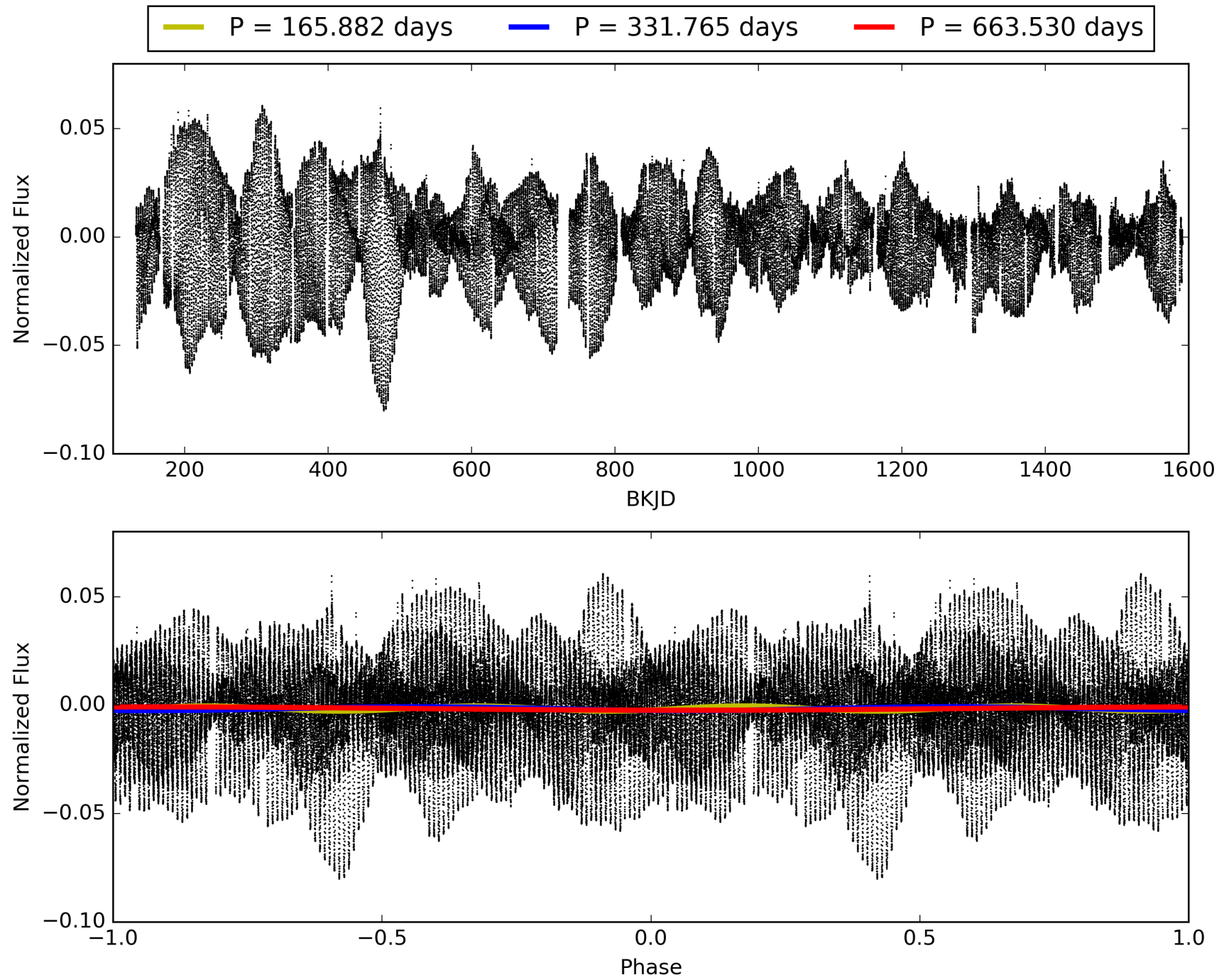
## DV Diagnostic Results:

ShortPeriod-sig: N/A  
LongPeriod-sig: 100.0% [40.62 $\sigma$ ]  
ModelChiSquare2-sig: 48.3%  
ModelChiSquareGof-sig: 99.9%  
Bootstrap-pfa: N/A  
RollingBand-fgt: 1.00 [3/3]  
GhostDiagnostic-chr: -2.205  
Centroid-sig: 70.0%  
Centroid-so: 0.593 arcsec [0.41 $\sigma$ ]  
OotOffset-rm: 1.618 arcsec [1.80 $\sigma$ ]  
OotOffset-st: 1/2/0/0 [3]  
KicOffset-rm: 1.575 arcsec [1.76 $\sigma$ ]  
KicOffset-st: 1/2/0/0 [3]  
DiffImageQuality-fgm: 0.33 [1/3]  
DiffImageOverlap-fno: 0.67 [2/3]

# TCE 002987160-02, PDC Light Curves



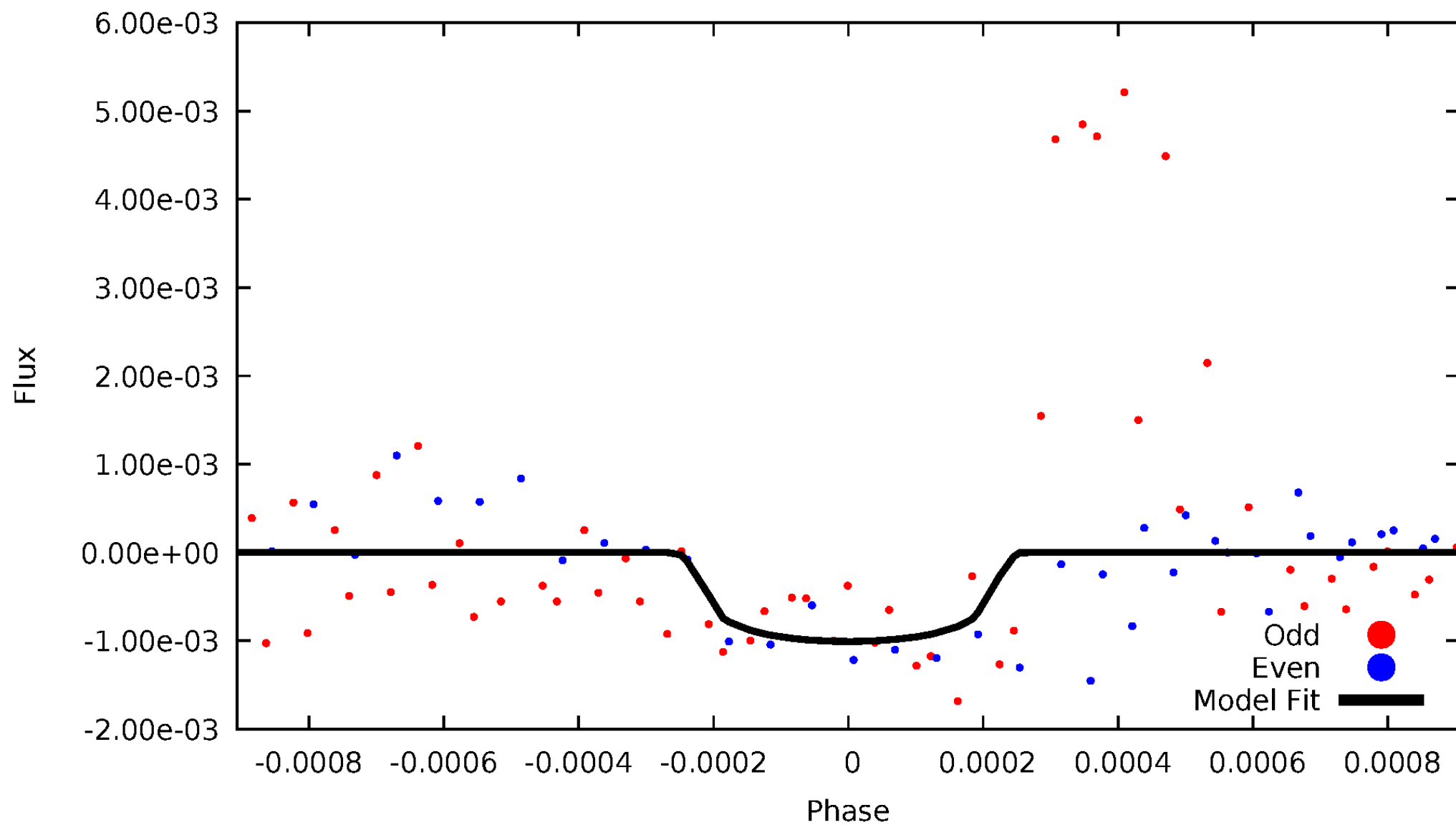
TCE 002987160-02





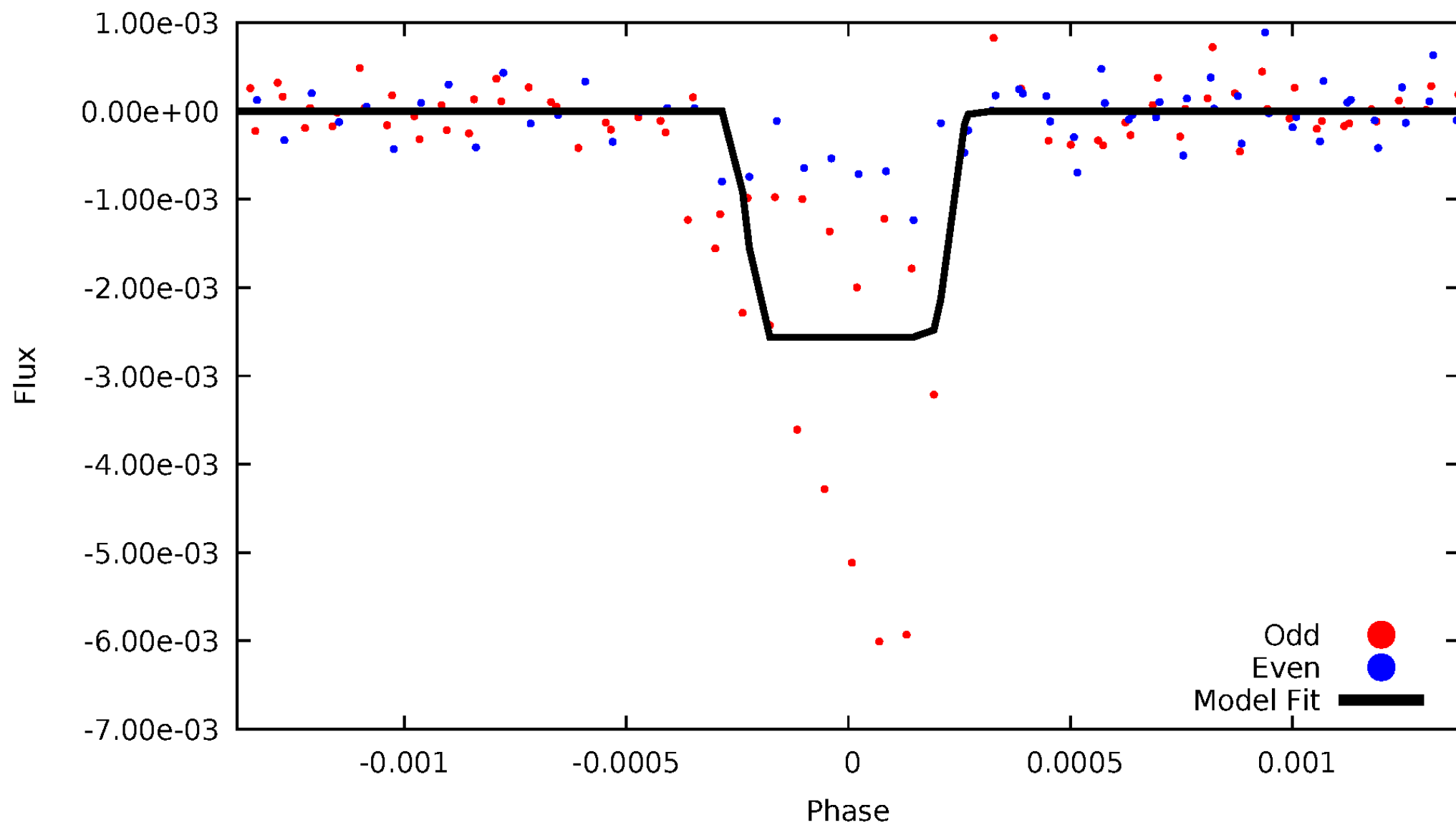
# DV Odd/Even

TCE 002987160-02



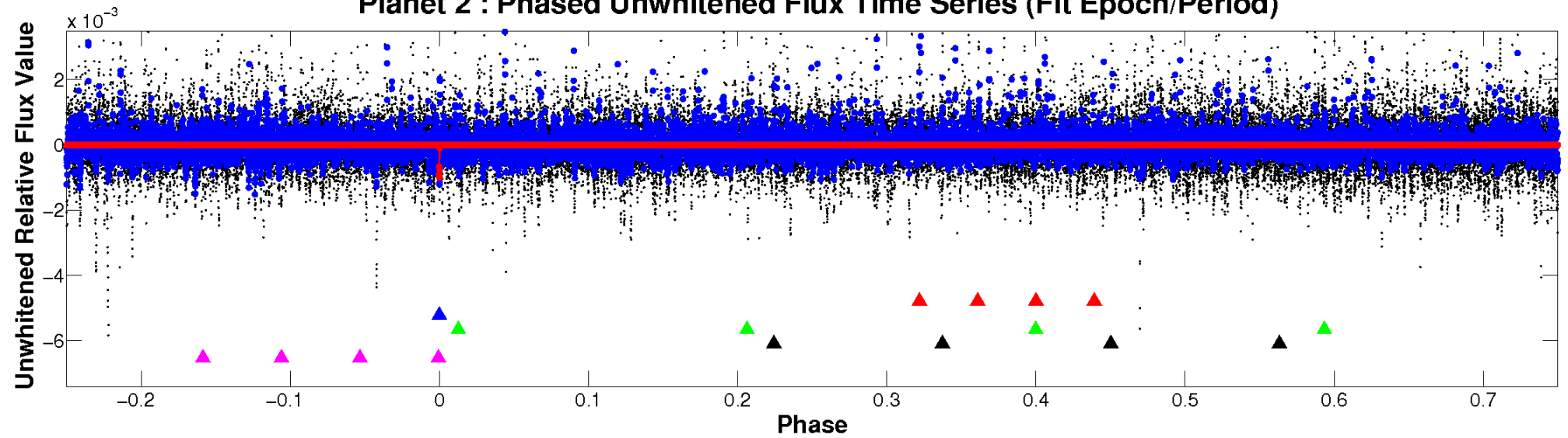
# ALT Odd/Even

TCE 002987160-02

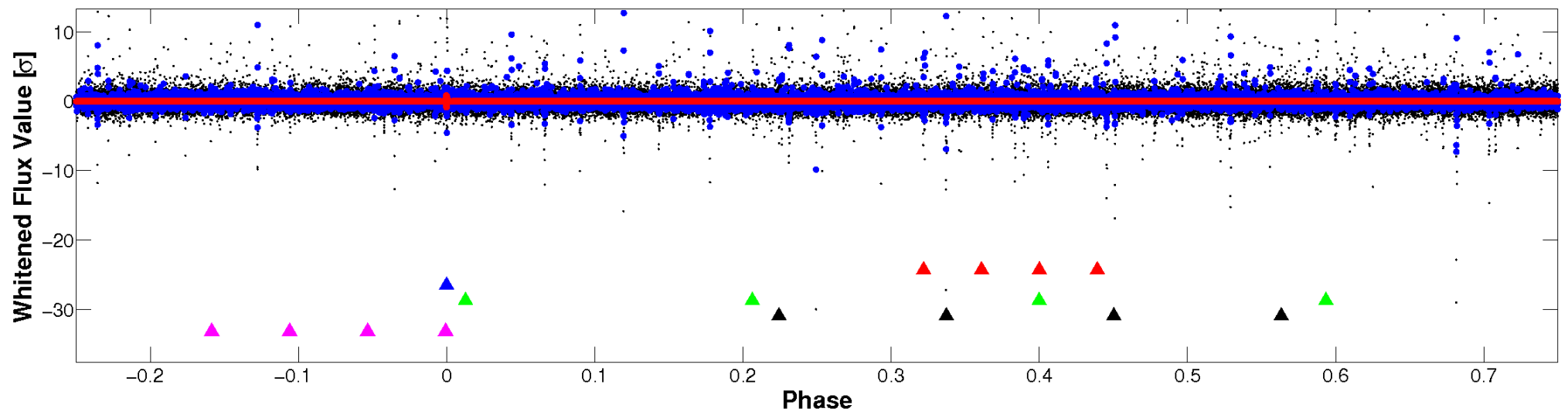


# Non-Whitened Vs. Whitened Light Curve

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

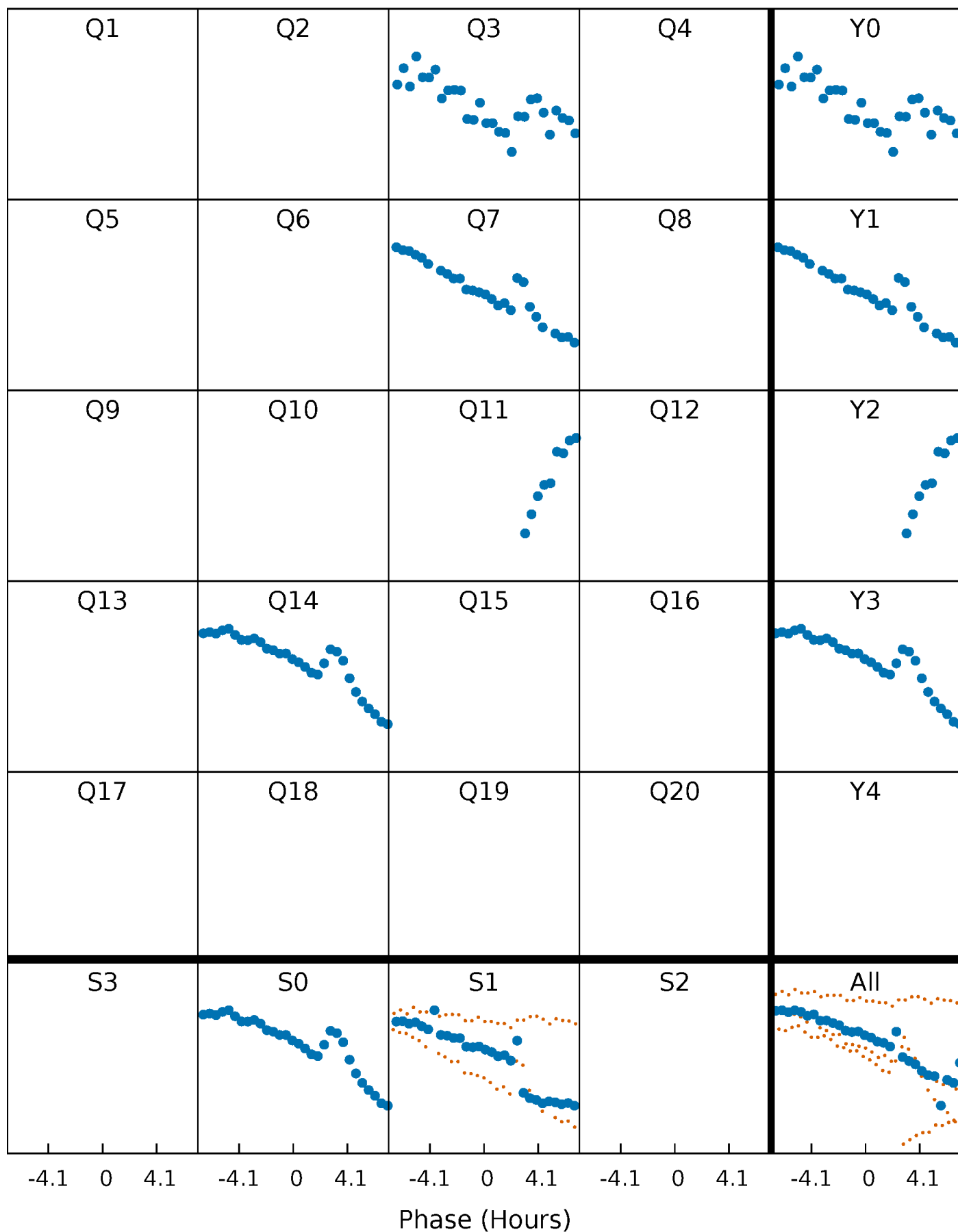


## Planet 2 : Phased Whitened Flux Time Series (Fit Epoch/Period)



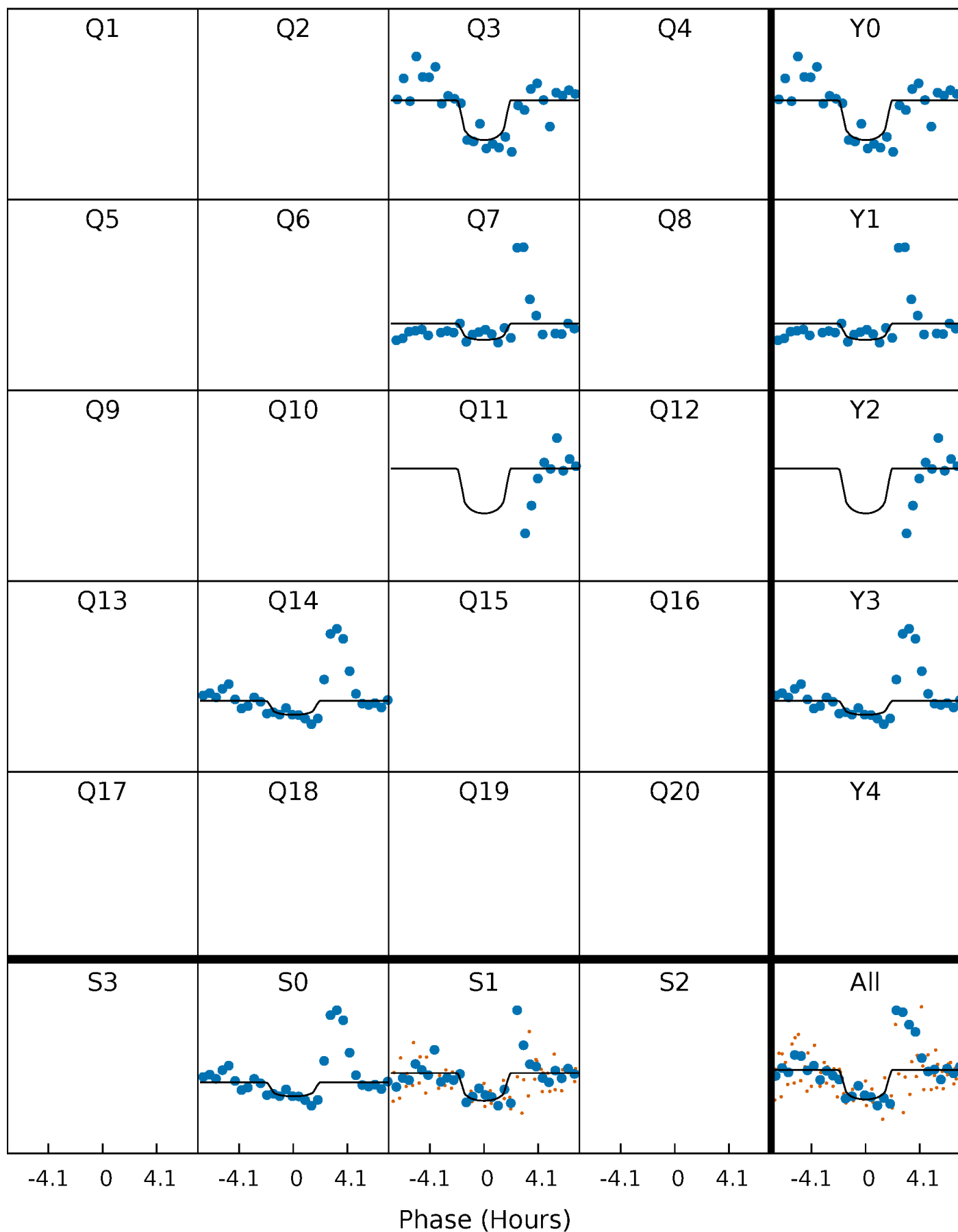
# PDC Quarter-Phased Transit Curves

TCE 002987160-02     $P=331.764796$  Days     $T_0=337.580356$  (BKJD)



# DV Quarter-Phased Transit Curves

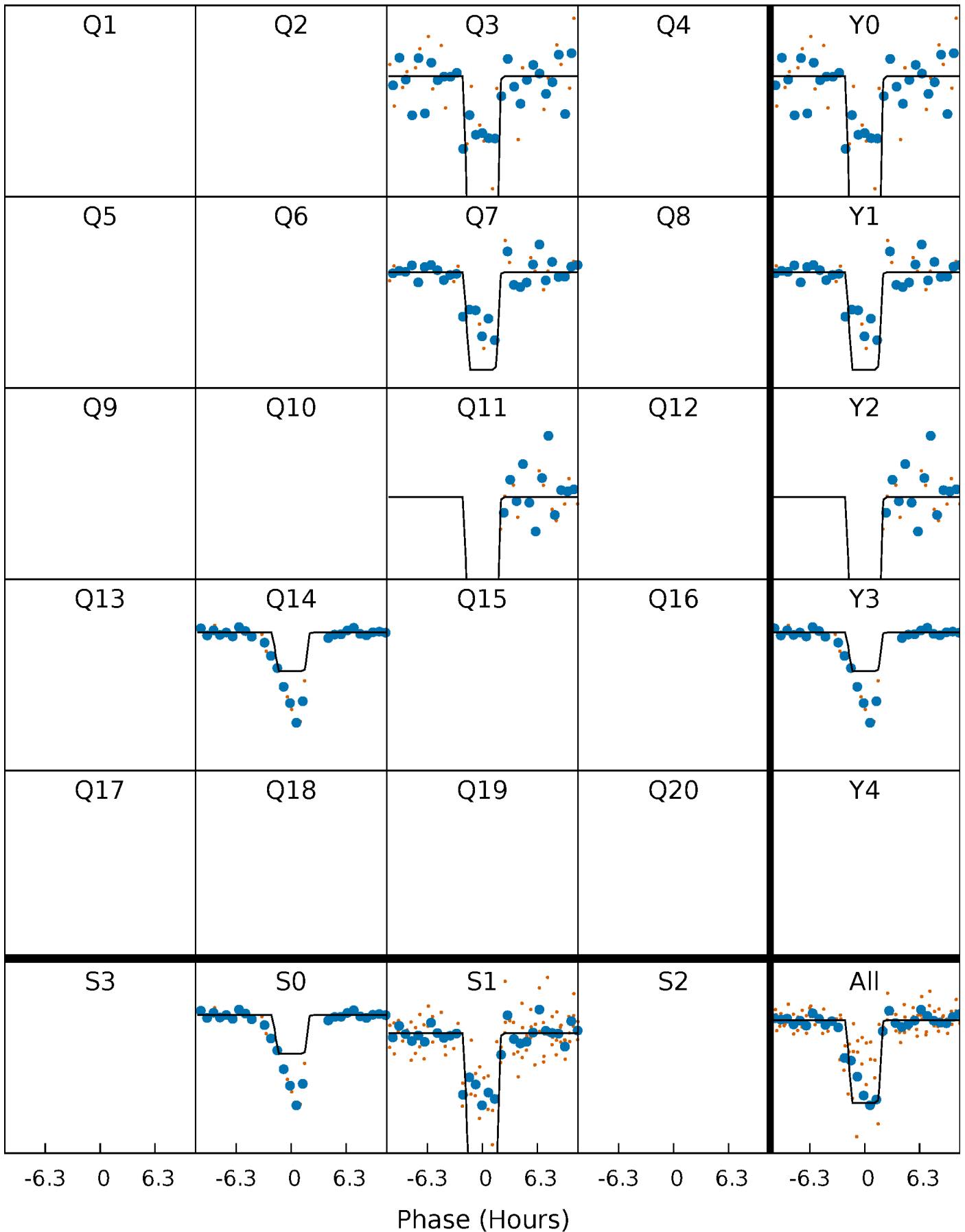
TCE 002987160-02     $P=331.764796$  Days     $T_0=337.580356$  (BKJD)





# Alt. Detrend Quarter-Phased Transit Curves

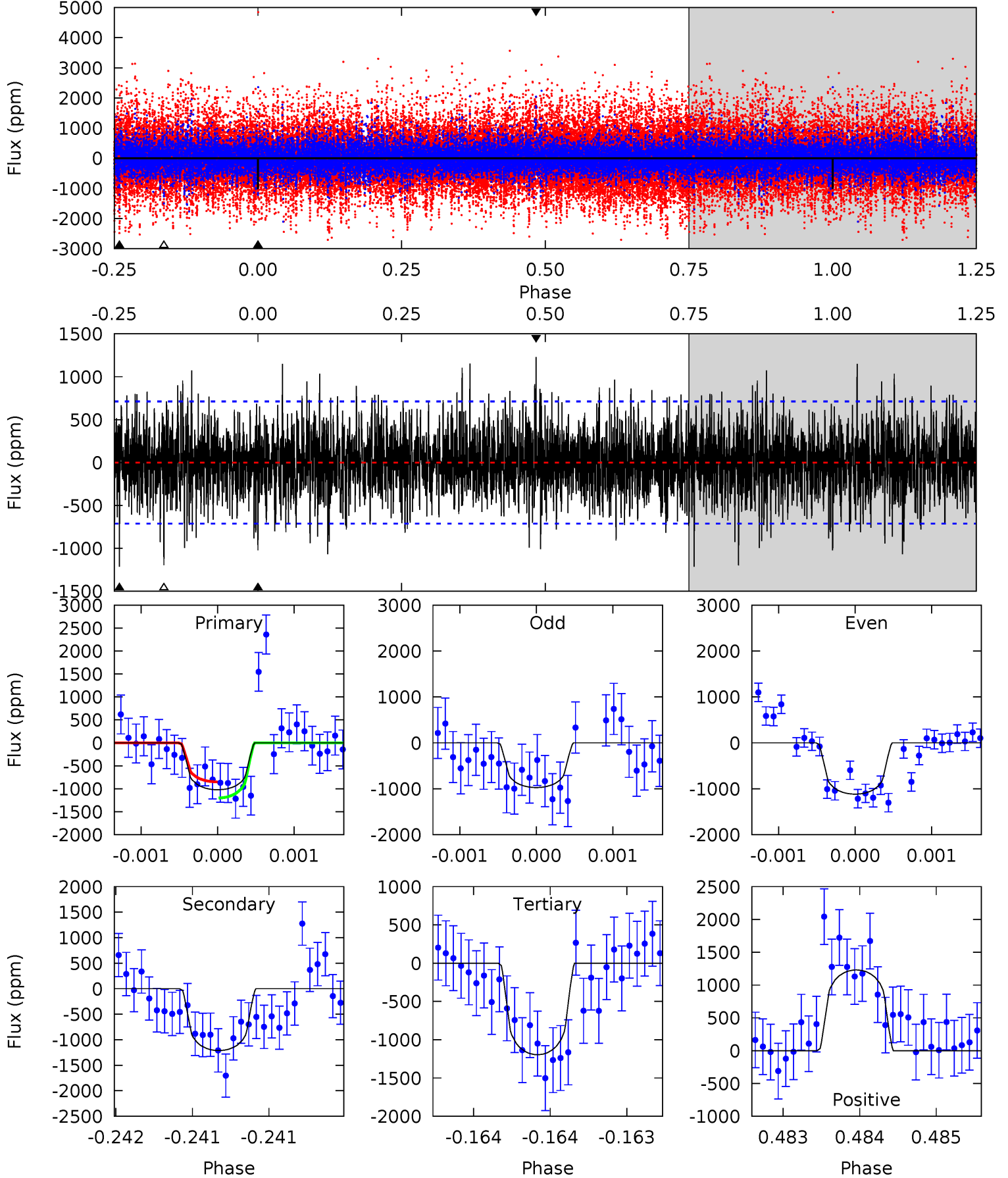
TCE 002987160-02 P=331.763179 Days  $T_0=337.616018$  (BKJD)



# DV Model-Shift Uniqueness Test

002987160-02, P = 331.764796 Days, E = 5.815560 Days

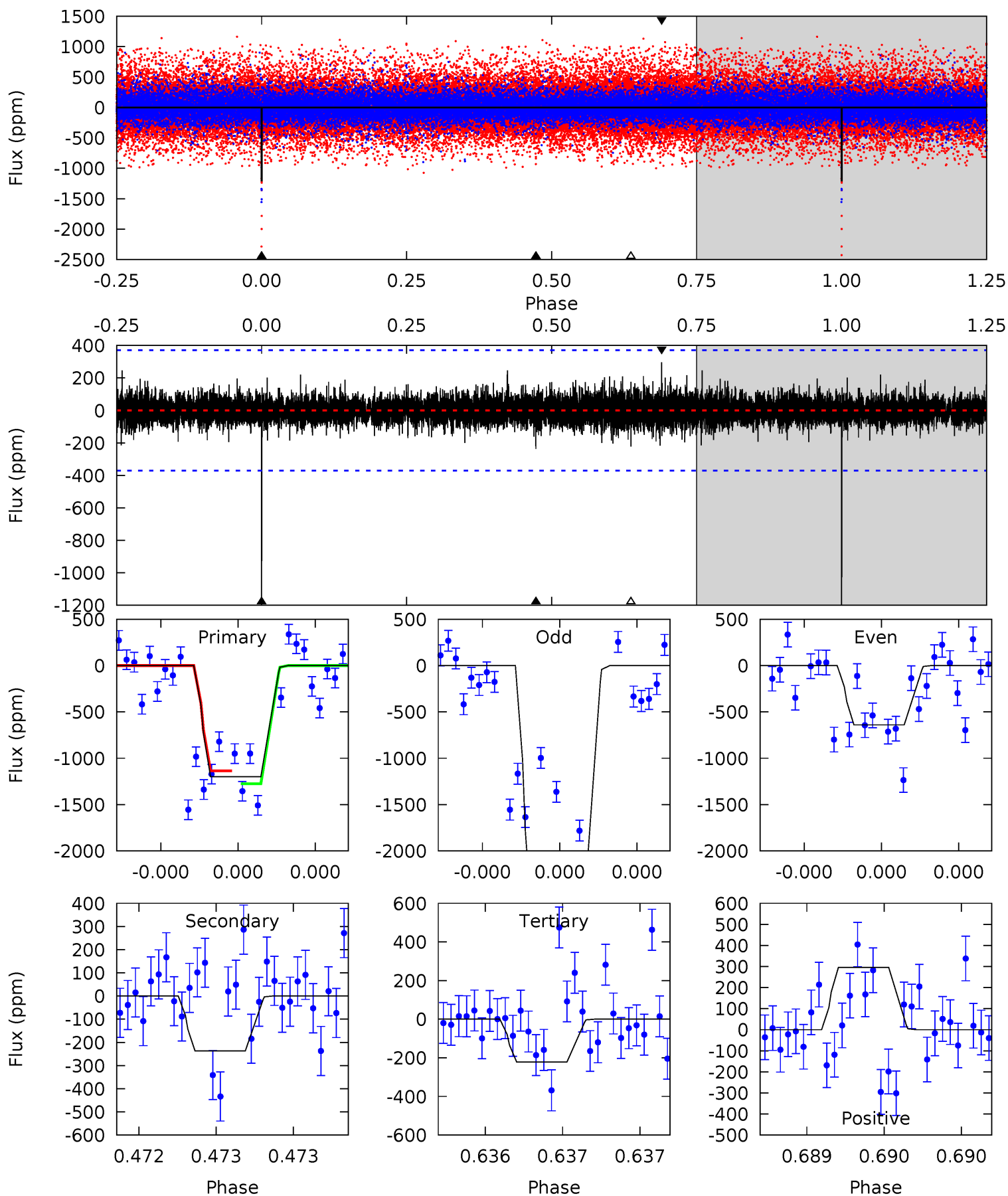
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
7.99	9.48	9.35	9.62	5.56	3.47	2.23	-1.37	-1.63	0.13	-0.14	0.50	0.92	0.50	1.38



# Alt Model-Shift Uniqueness Test

002987160-02, P = 331.763179 Days, E = 5.852839 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
18.0	3.56	3.33	4.44	5.57	3.48	0.75	14.7	13.6	0.23	-0.88	19.2	1.53	0.20	1.05



### Stellar Parameters For KIC 002987160

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R (R_{\odot})$	$M(M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$5551^{+166}_{-166}$	$4.455^{+0.139}_{-0.186}$	$-0.480^{+0.300}_{-0.300}$	$0.844^{+0.182}_{-0.121}$	$0.742^{+0.118}_{-0.047}$	$1.738^{+1.037}_{-0.750}$
	+3%/-3%	+3%/-4%	+62%/-62%	+22%/-14%	+16%/-6%	+60%/-43%
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 002987160-02 / KOI

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{max} (K)$	$T_{obs} (K)$	$A_{obs}$
DV	$-1213 \pm 128$	$5.82^{+5.36}_{-4.08}$	$344^{+23}_{-19}$	$4380^{+3497}_{-889}$	$14268^{+161680}_{-10411}$
Alt.	$-237 \pm 67$	$6.37^{+5.91}_{-4.10}$	$344^{+23}_{-17}$	$3225^{+1375}_{-561}$	$2344^{+16682}_{-1773}$

$T_{max}$  = 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

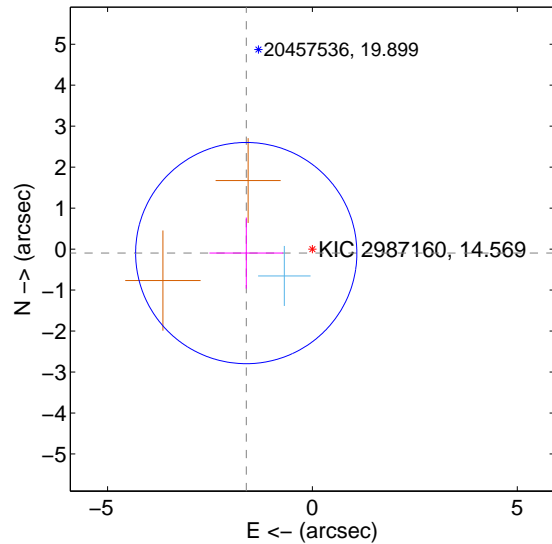
Supplemental centroid analysis for 002987160-02. Kepler magnitude: 14.57. Transit SNR 4.16

There are 1 quarters with good PRF difference image offsets

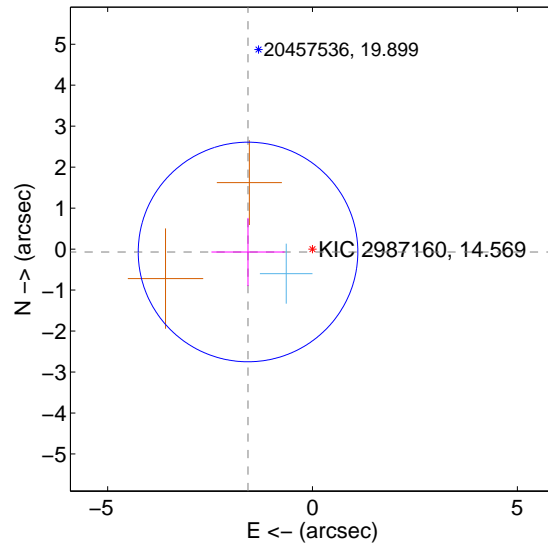
The direct PRF centroid is offset from the target star catalog position by about 0.06 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$1.618 \pm 0.900$	1.80	$1.615 \pm 0.900$	$-0.097 \pm 0.867$
PRF-fit source offset from KIC position	$1.575 \pm 0.893$	1.76	$1.574 \pm 0.893$	$-0.070 \pm 0.832$
photometric centroid source offset	$0.59 \pm 1.44$	0.41	$-0.39 \pm 1.26$	$0.45 \pm 1.57$

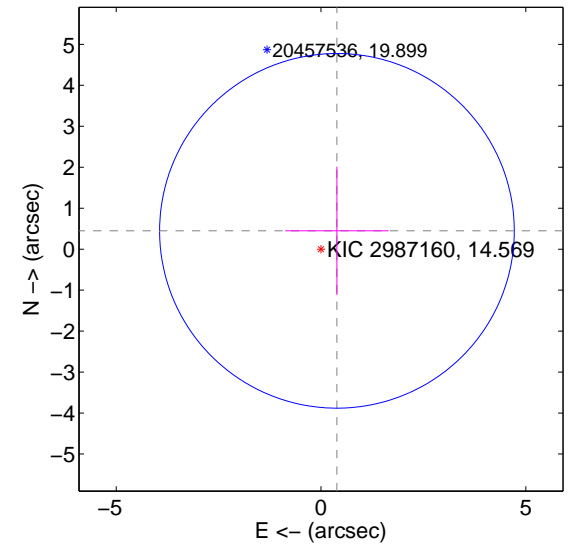
offset from difference PRF-fit to OOT PRF-fit



offset from difference PRF-fit to KIC position



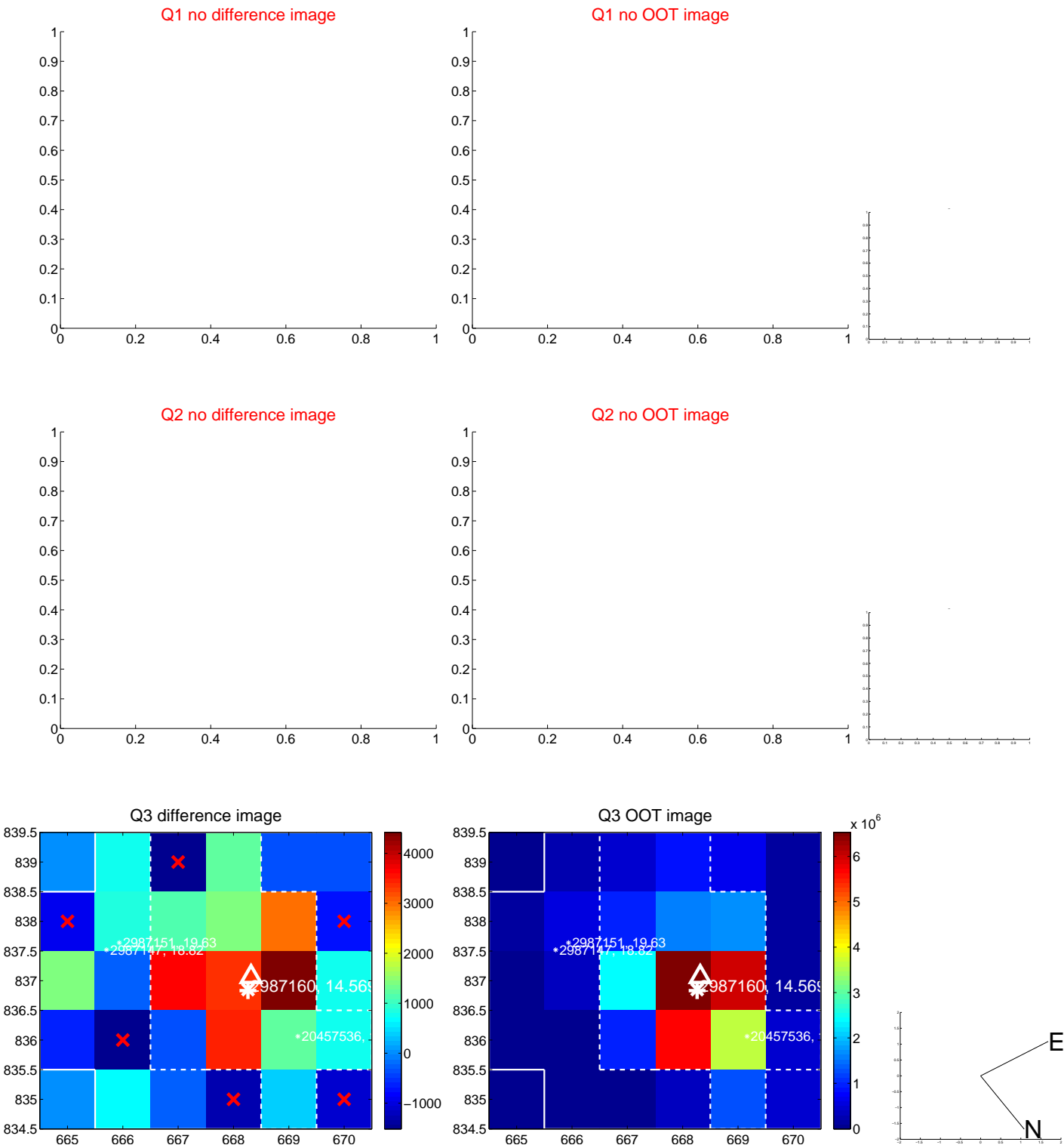
offset from photometric centroids



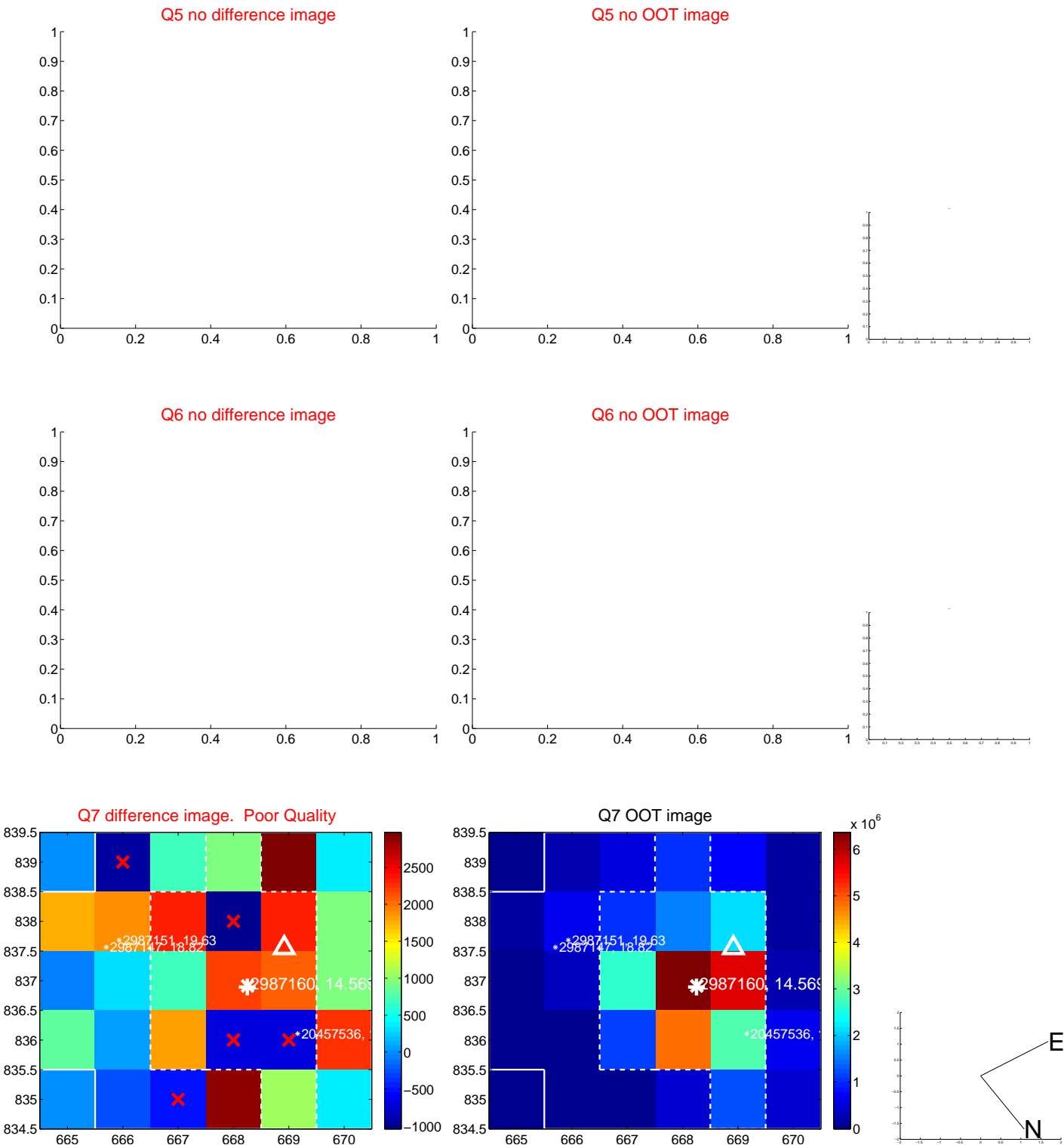
Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets**; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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



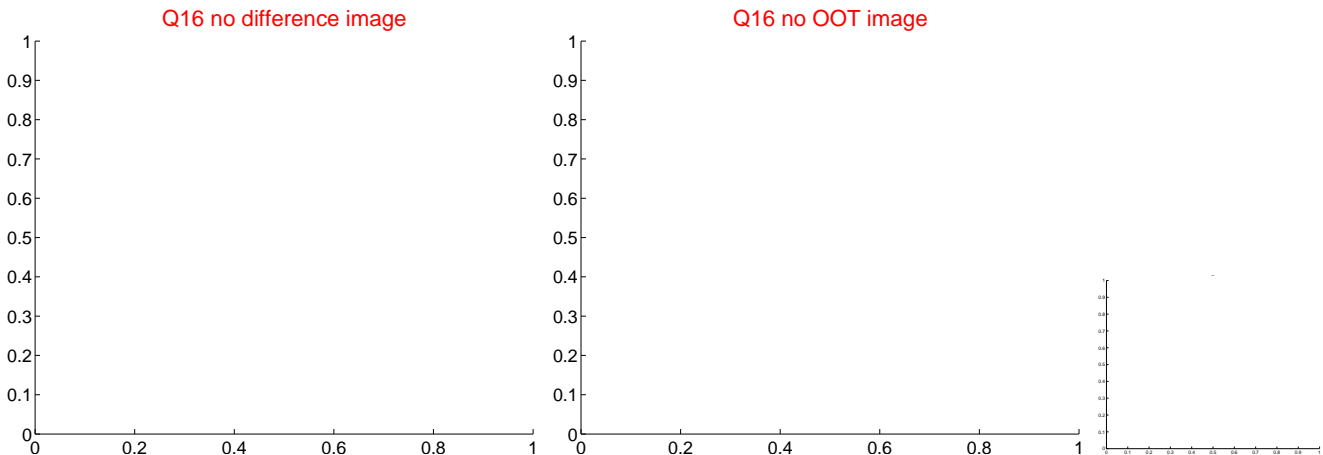
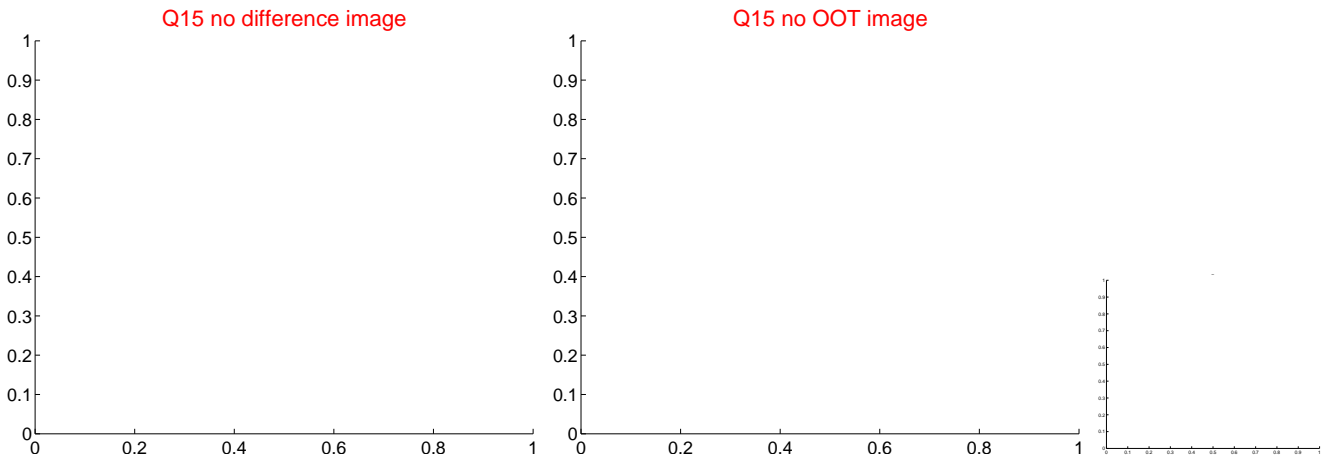
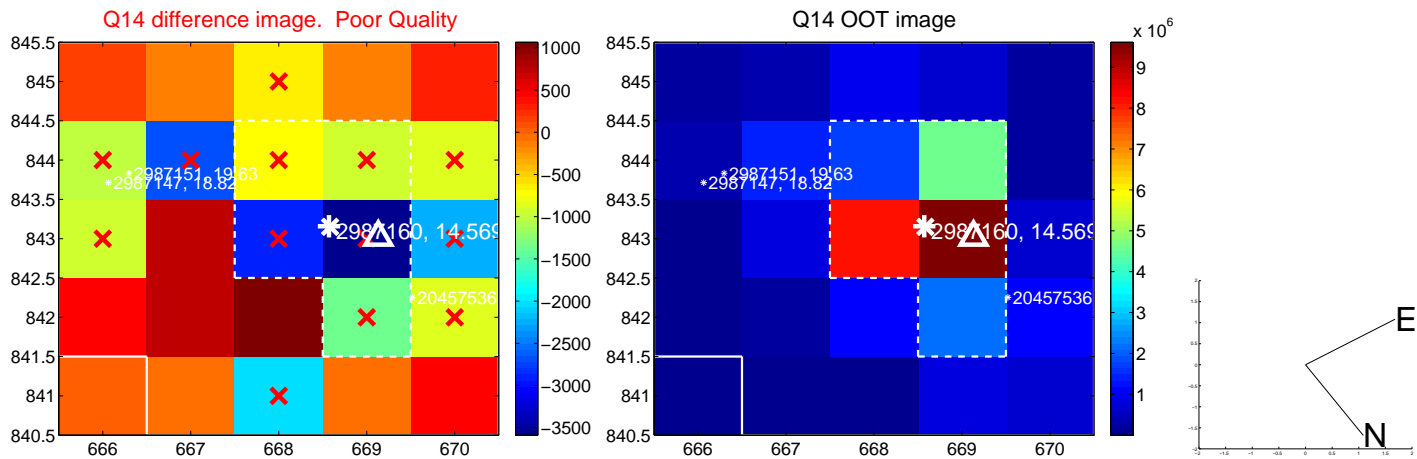
white ×: KIC target position; +: OOT centroid; △: difference centroid. red ✕: large negative pixel value.



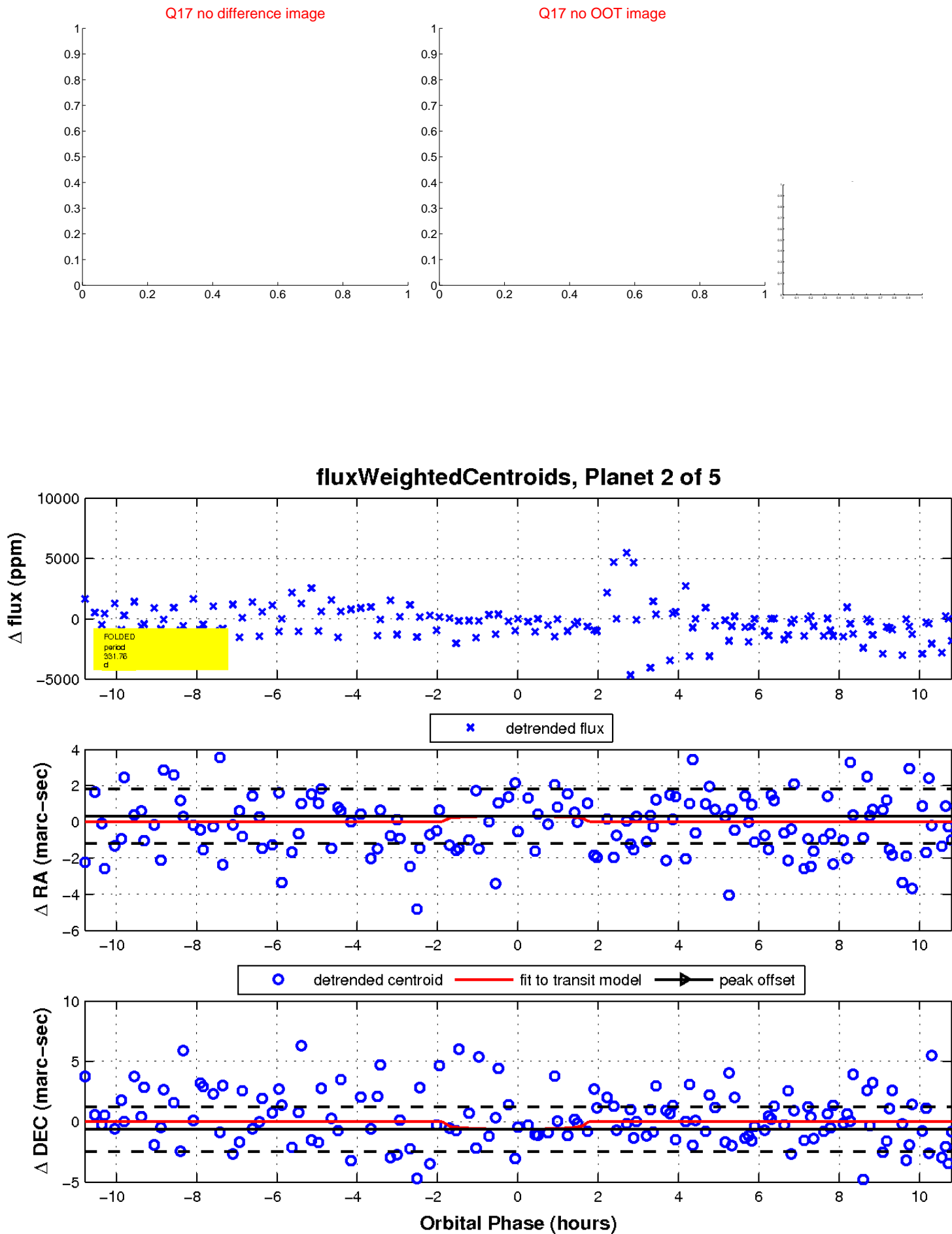
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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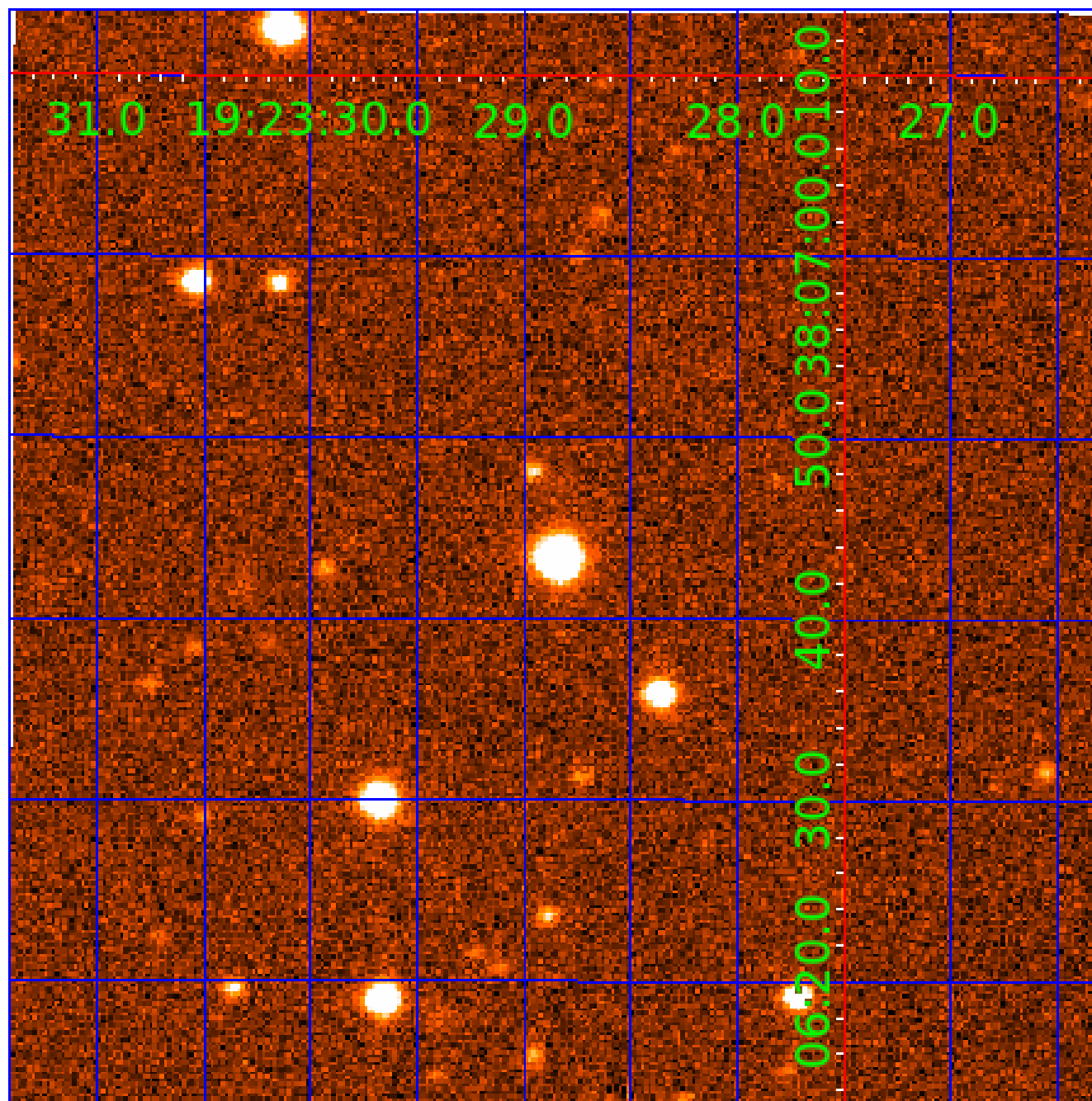
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.





UKIRT Image

Declination



# KIC 002987160

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
002987160-02	OBS	No	331.764796	337.580356	1005.9	3.607	12.8	4.2	0.84	5551	2.66	0.84
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## Robovetter Results

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002987160-03	OBS	FP	0.00	1	0	1	0	LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV—INCONSISTENT_TRANS—CENT_FEW_DIFFS—HALO_GHOST
002987160-04	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_CHASES_MARSHALL—LPP_DV—LPP_ALT—ALL_TRANS_CHASES—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV—CENT_FEW_DIFFS
002987160-05	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_CHASES—LPP_DV—LPP_ALT—ALL_TRANS_CHASES—INCONSISTENT_TRANS—CENT_NOFITS

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

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

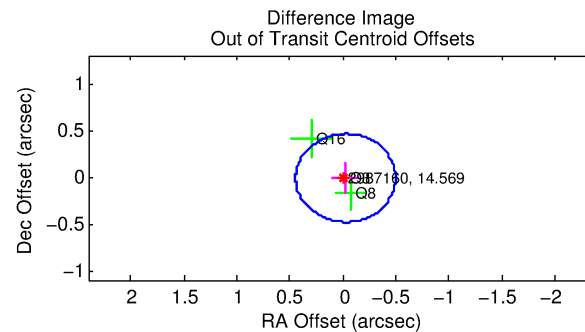
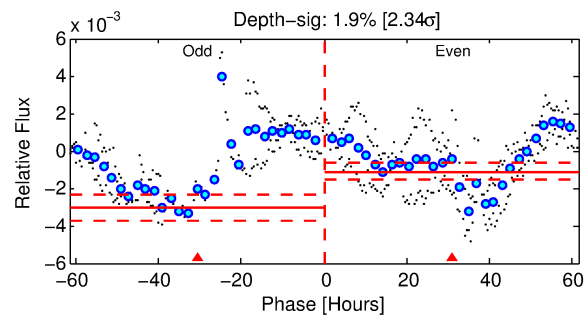
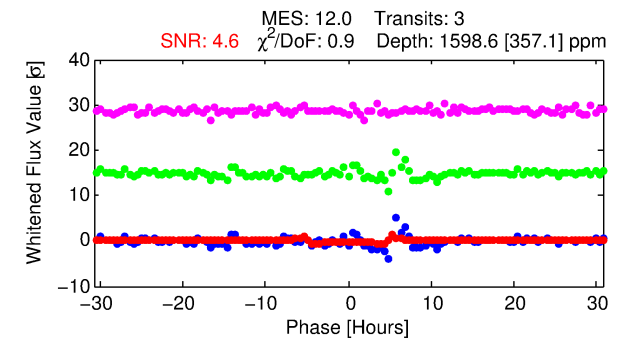
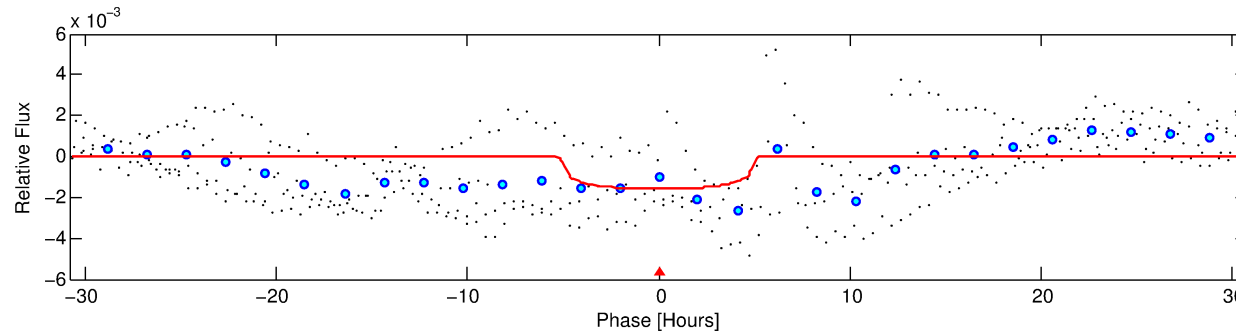
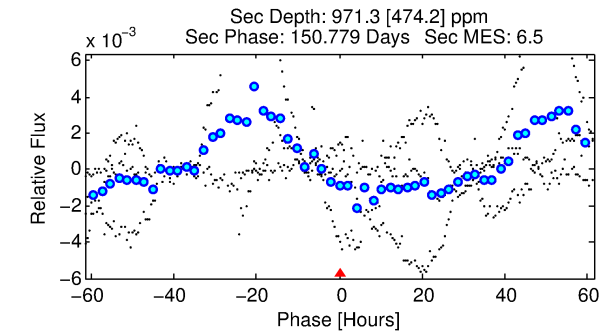
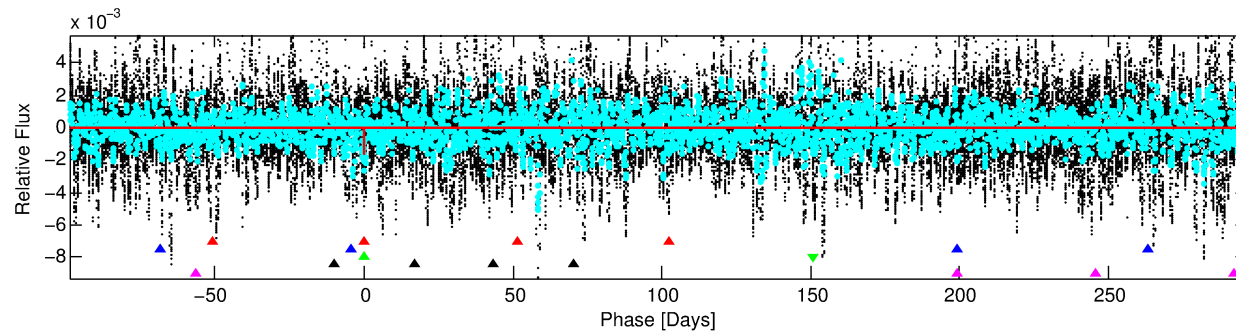
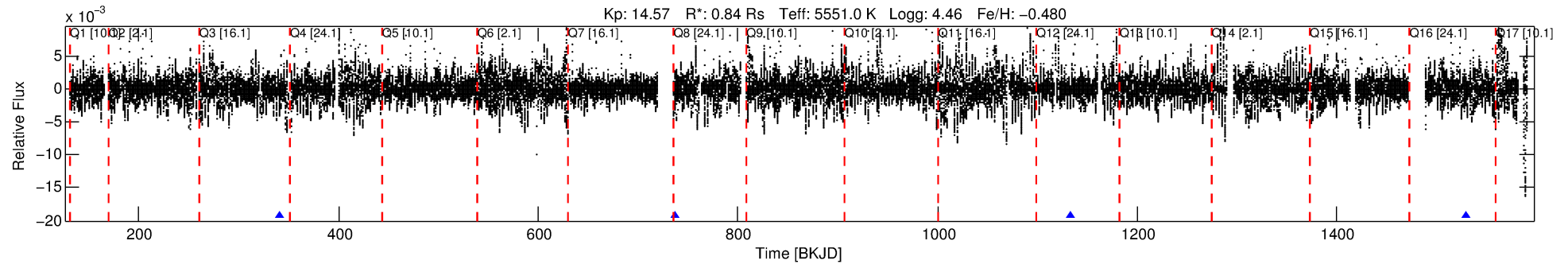
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 002987160-03

No Significant Match Found

# DV One-Page Summary

KIC: 2987160 Candidate: 3 of 5 Period: 395.979 d



## DV Fit Results:

Period = 395.97922 [0.00350] d  
Epoch = 341.8236 [0.0084] BKJD  
Rp/R\* = 0.0363 [0.0127]  
a/R\* = 304.12 [399.64]  
b = 0.09 [15.11]  
Seff = 0.66 [0.23]  
Teq = 230 [20] K  
Rp = 3.34 [1.37] Re  
a = 0.9551 [0.1935] AU  
Ag = 43612.08 [39728.93] [1.10 $\sigma$ ]  
Teffp = 5144 [1108] K [4.44 $\sigma$ ]

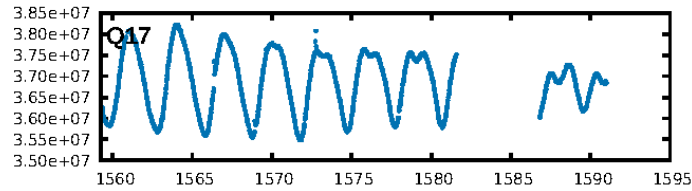
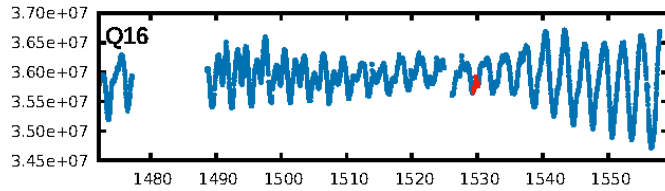
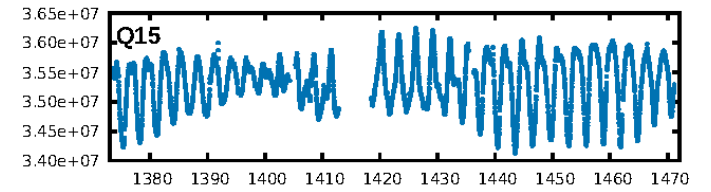
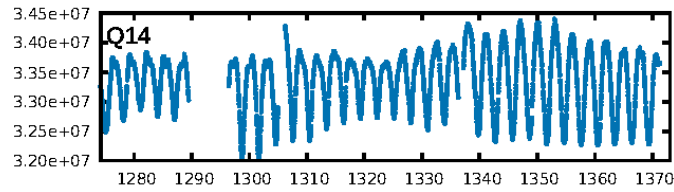
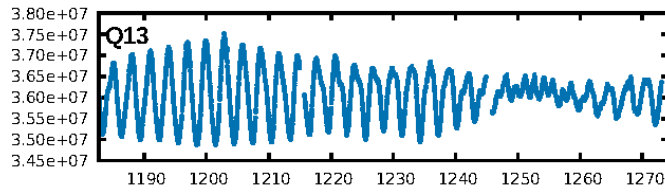
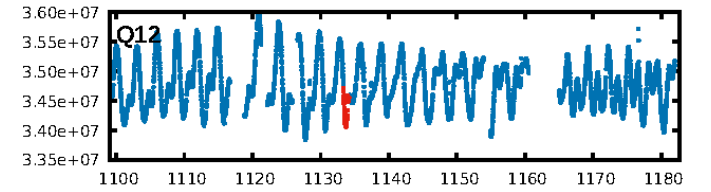
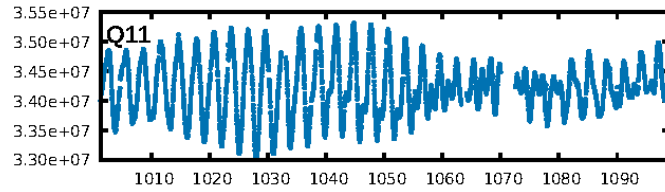
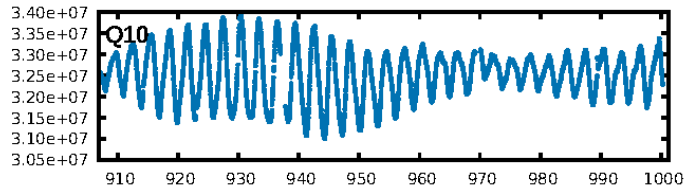
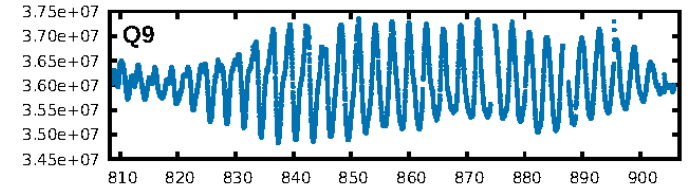
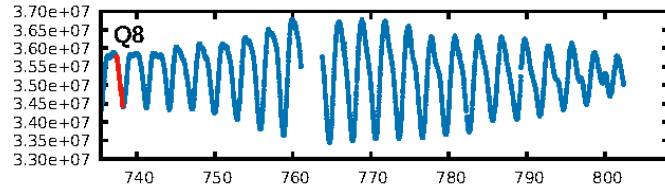
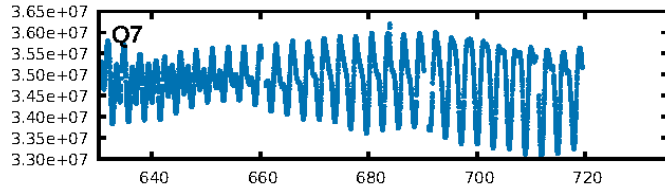
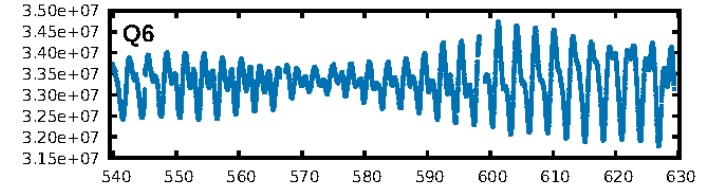
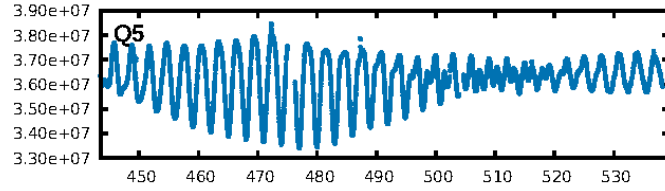
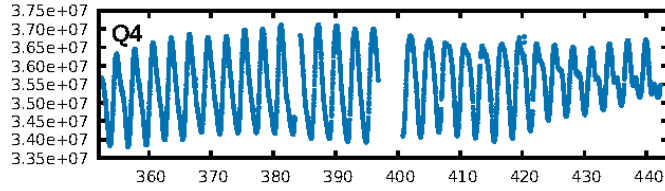
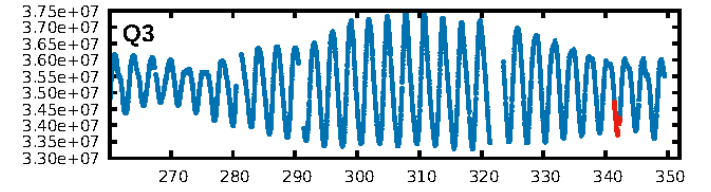
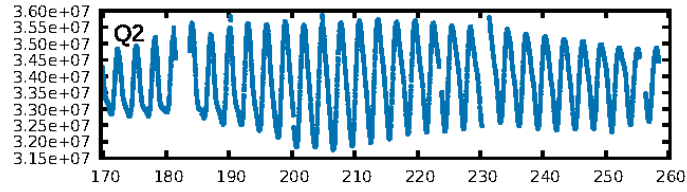
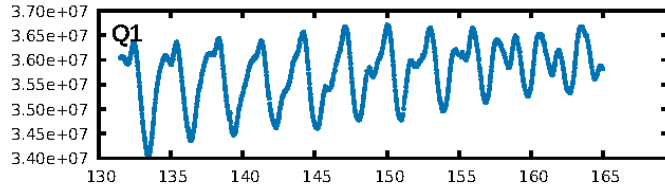
## DV Diagnostic Results:

ShortPeriod-sig: 100.0% [60.01 $\sigma$ ]  
LongPeriod-sig: N/A  
ModelChiSquare2-sig: 36.2%  
ModelChiSquareGof-sig: 99.7%  
Bootstrap-pfa: N/A  
RollingBand-fgt: 1.00 [3/3]  
GhostDiagnostic-chr: 0.07721  
Centroid-sig: 1.7%  
Centroid-so: 0.855 arcsec [1.82 $\sigma$ ]  
OotOffset-rm: 0.030 arcsec [0.19 $\sigma$ ]  
OotOffset-st: 0/1/2/0 [3]  
KicOffset-rm: 0.081 arcsec [0.75 $\sigma$ ]  
KicOffset-st: 0/1/2/0 [3]  
DiffImageQuality-fgm: 0.33 [1/3]  
DiffImageOverlap-fno: 1.00 [3/3]

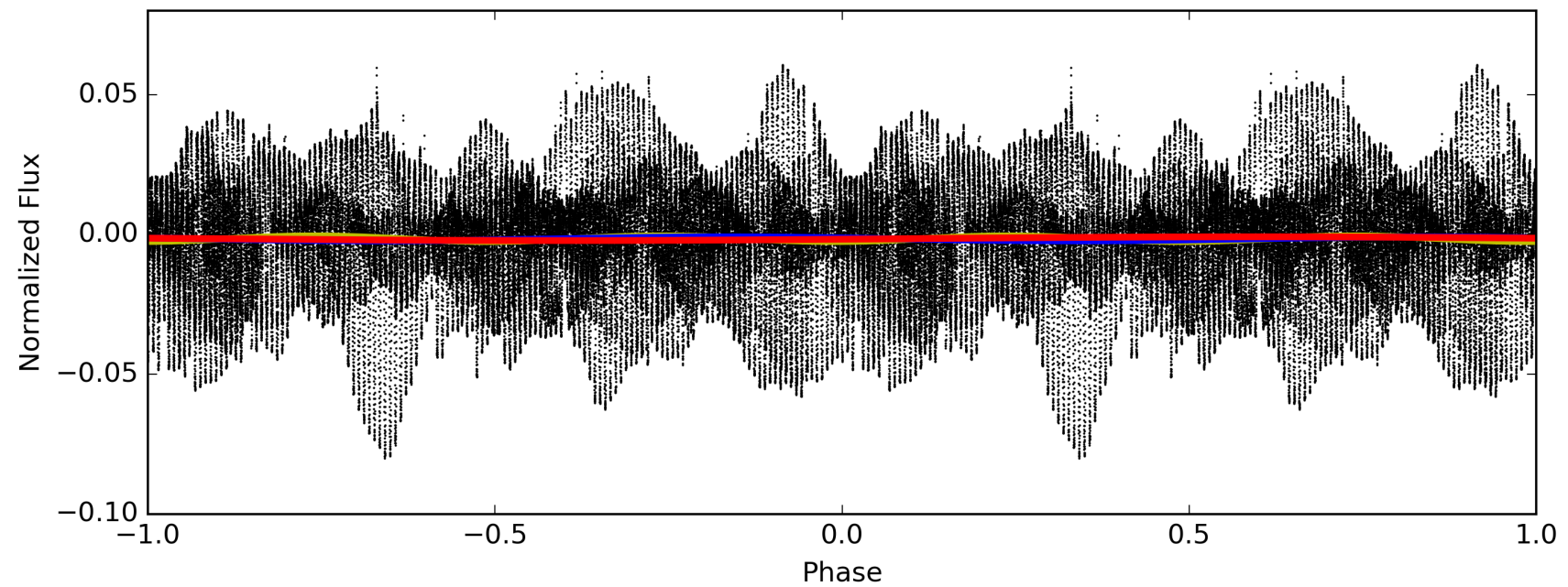
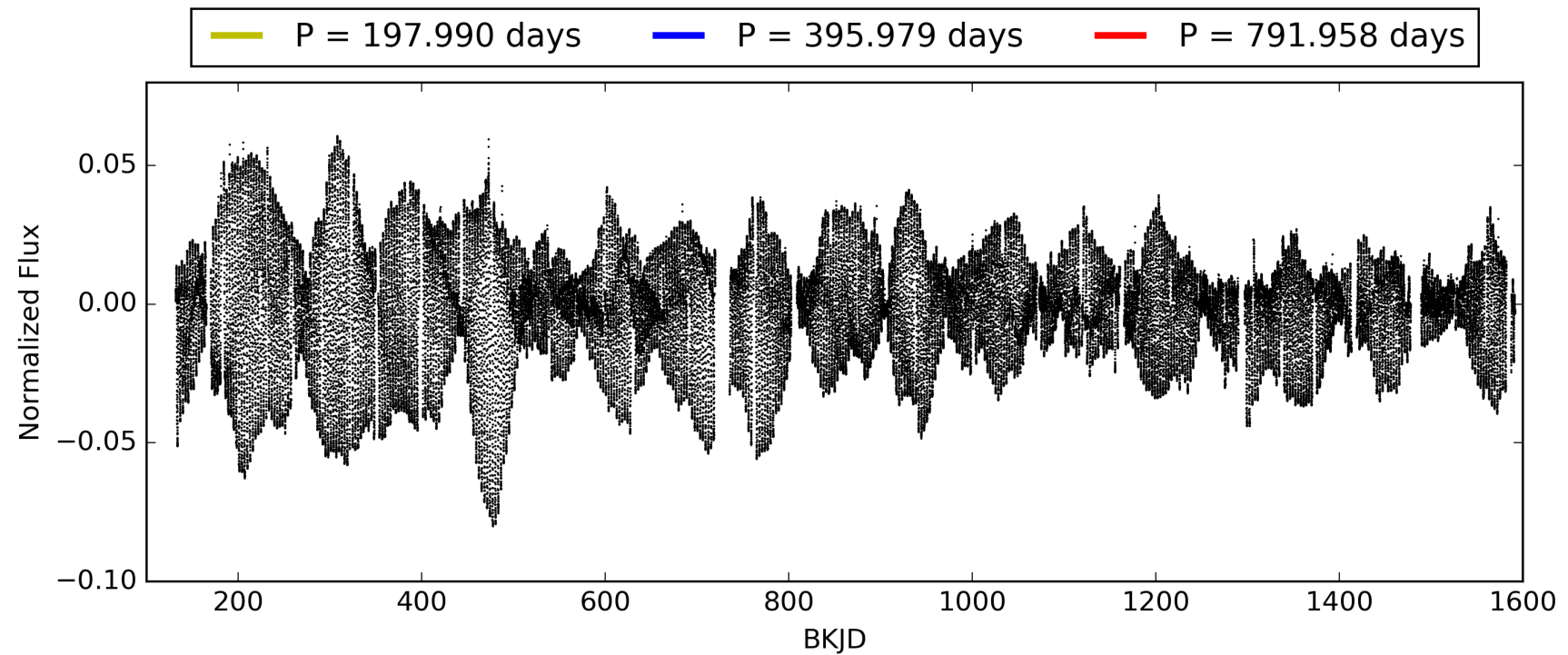
Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 03-Feb-2016 07:57:32 Z

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

# TCE 002987160-03, PDC Light Curves



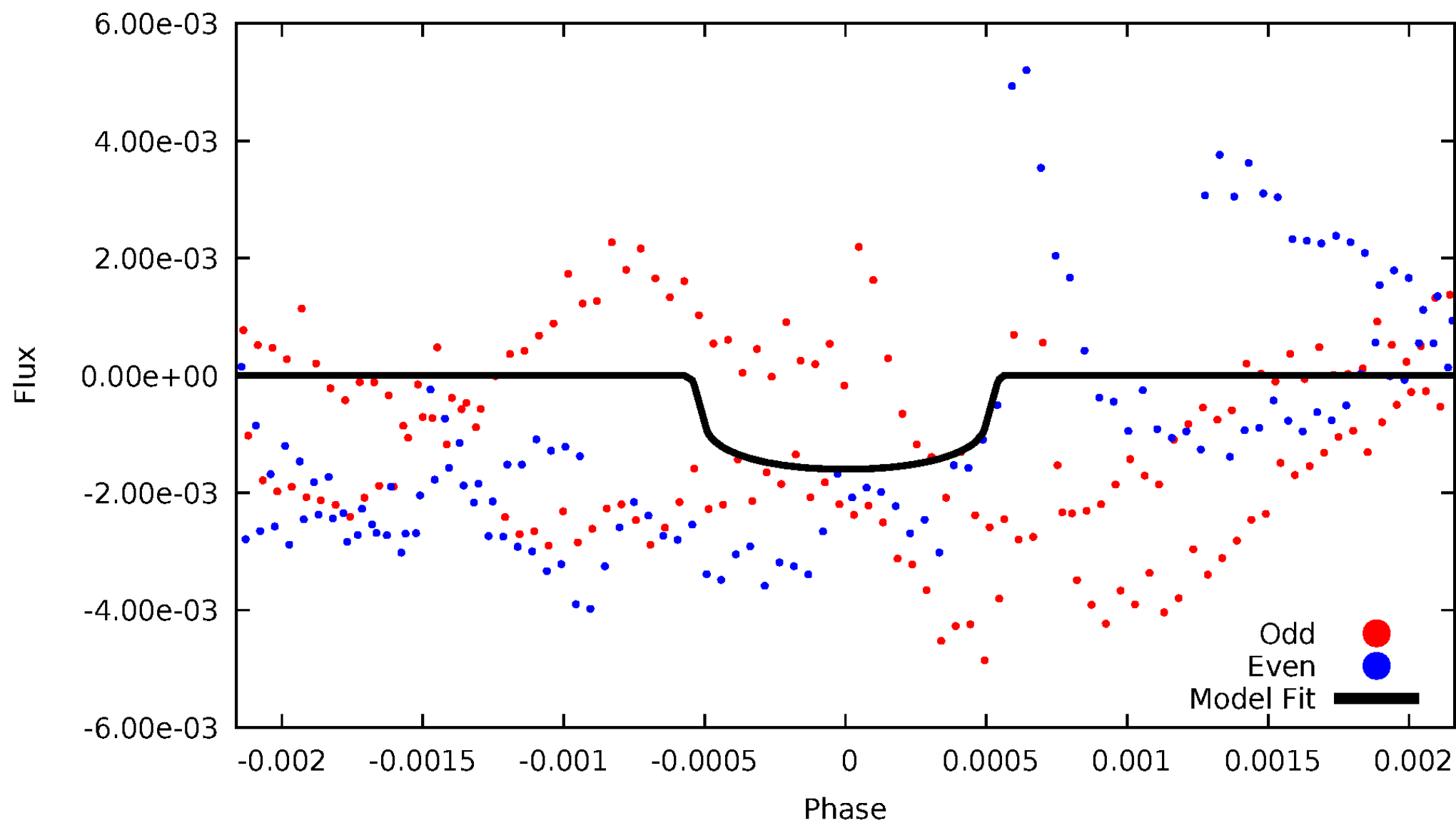
TCE 002987160-03





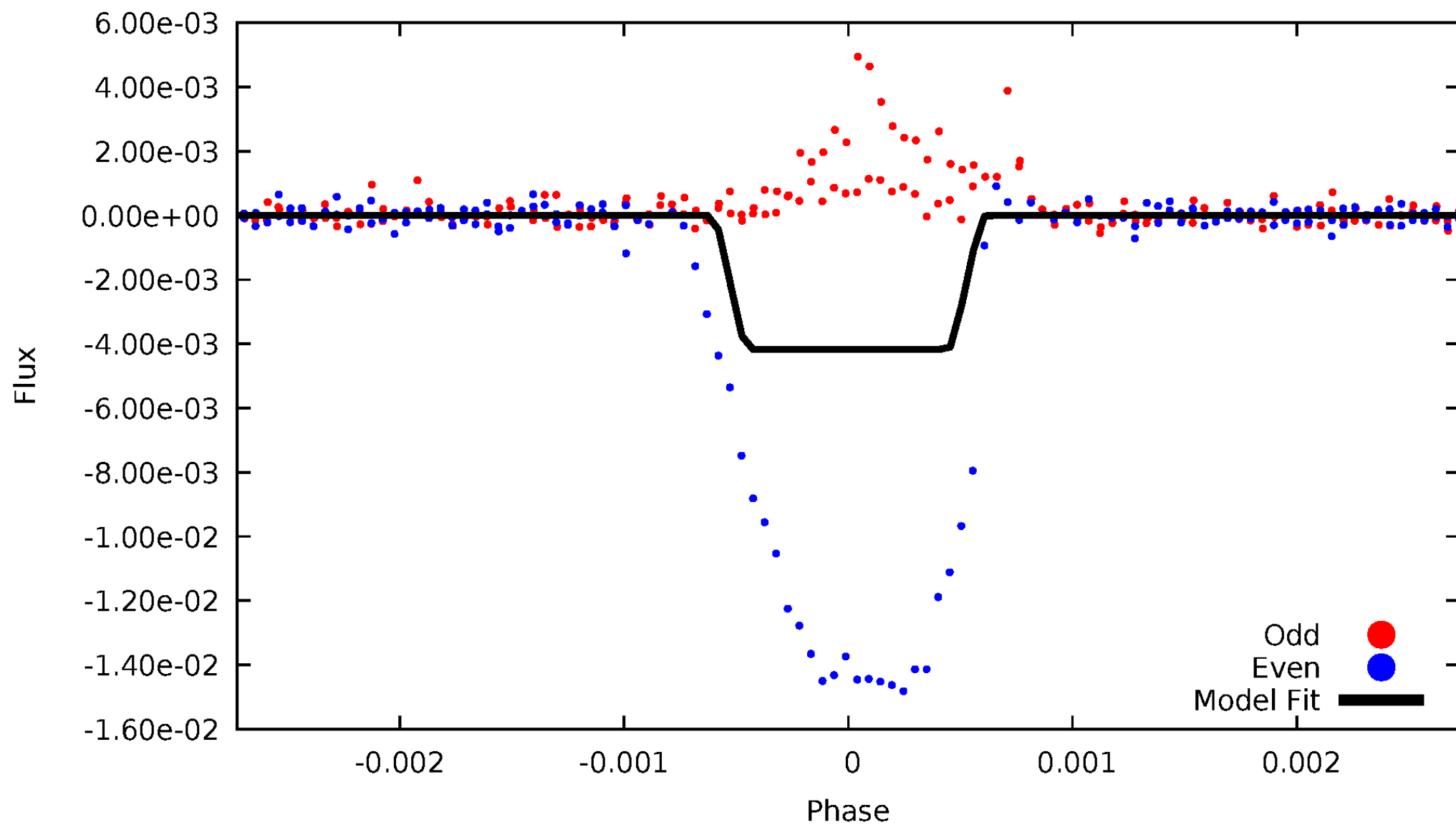
# DV Odd/Even

TCE 002987160-03



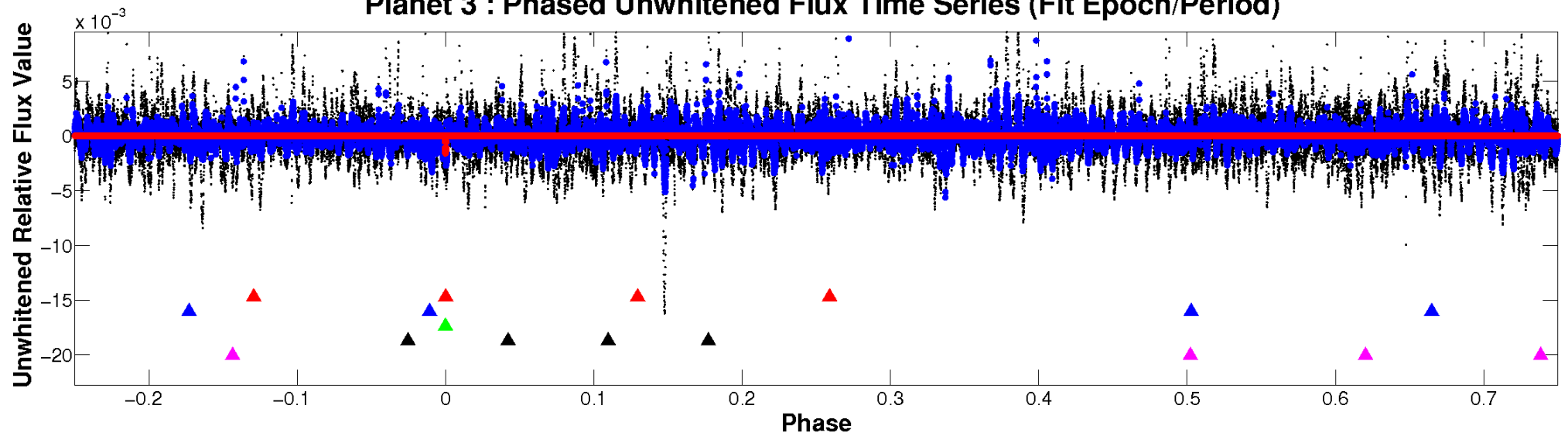
# ALT Odd/Even

TCE 002987160-03

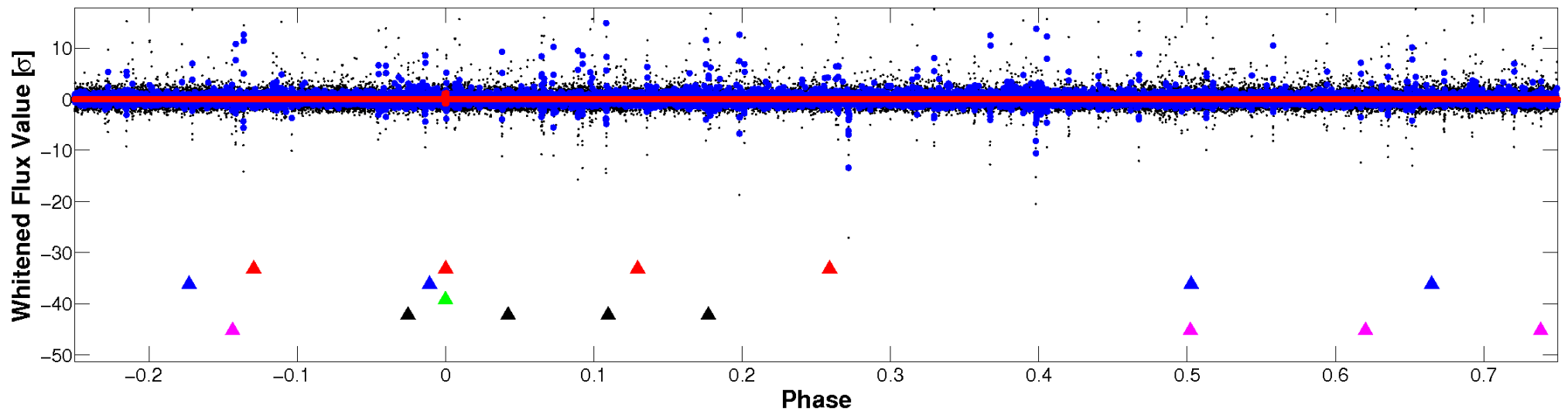


# Non-Whitened Vs. Whitened Light Curve

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

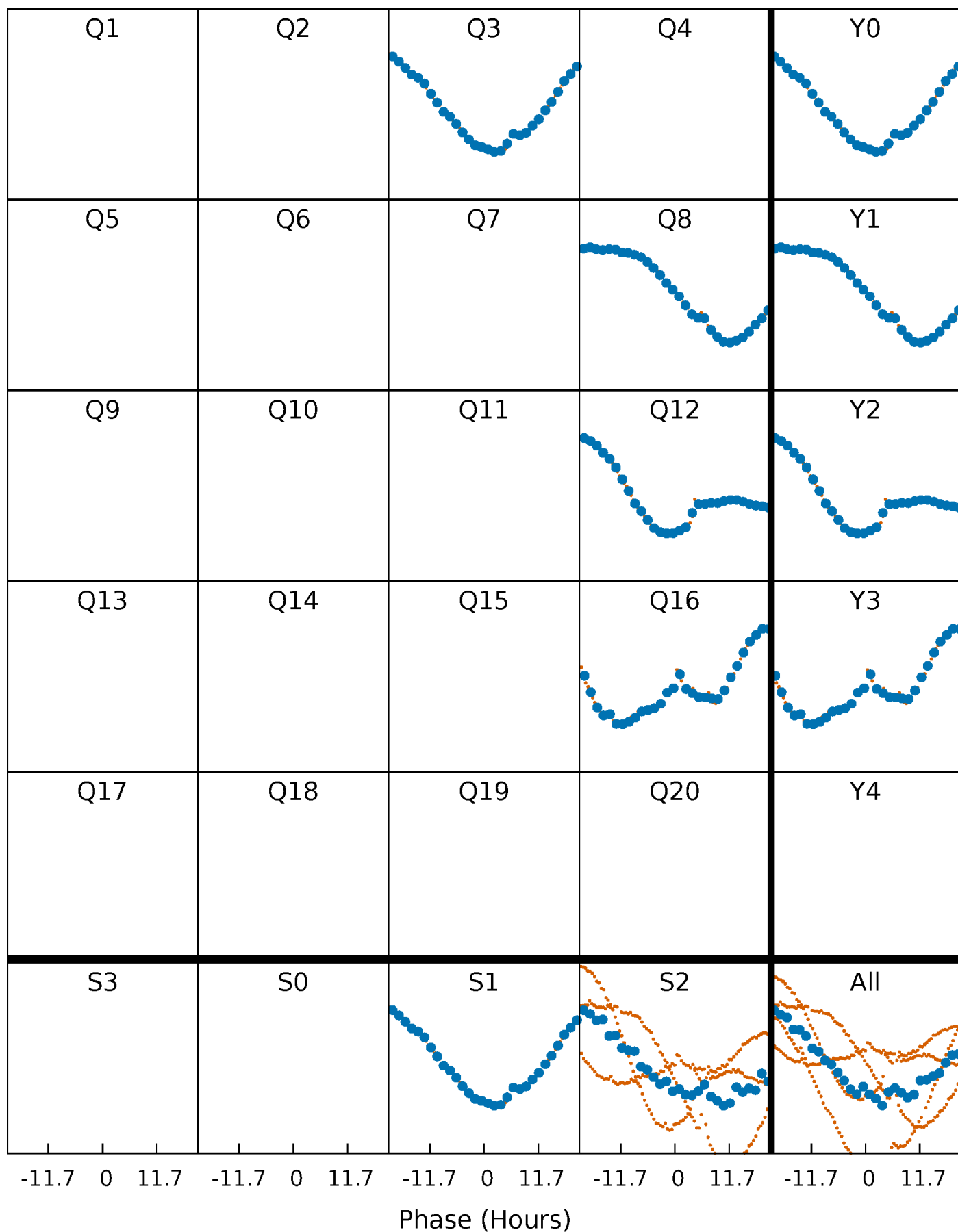


Planet 3 : Phased Whitened Flux Time Series (Fit Epoch/Period)



# PDC Quarter-Phased Transit Curves

TCE 002987160-03     $P=395.979224$  Days     $T_0=341.823625$  (BKJD)



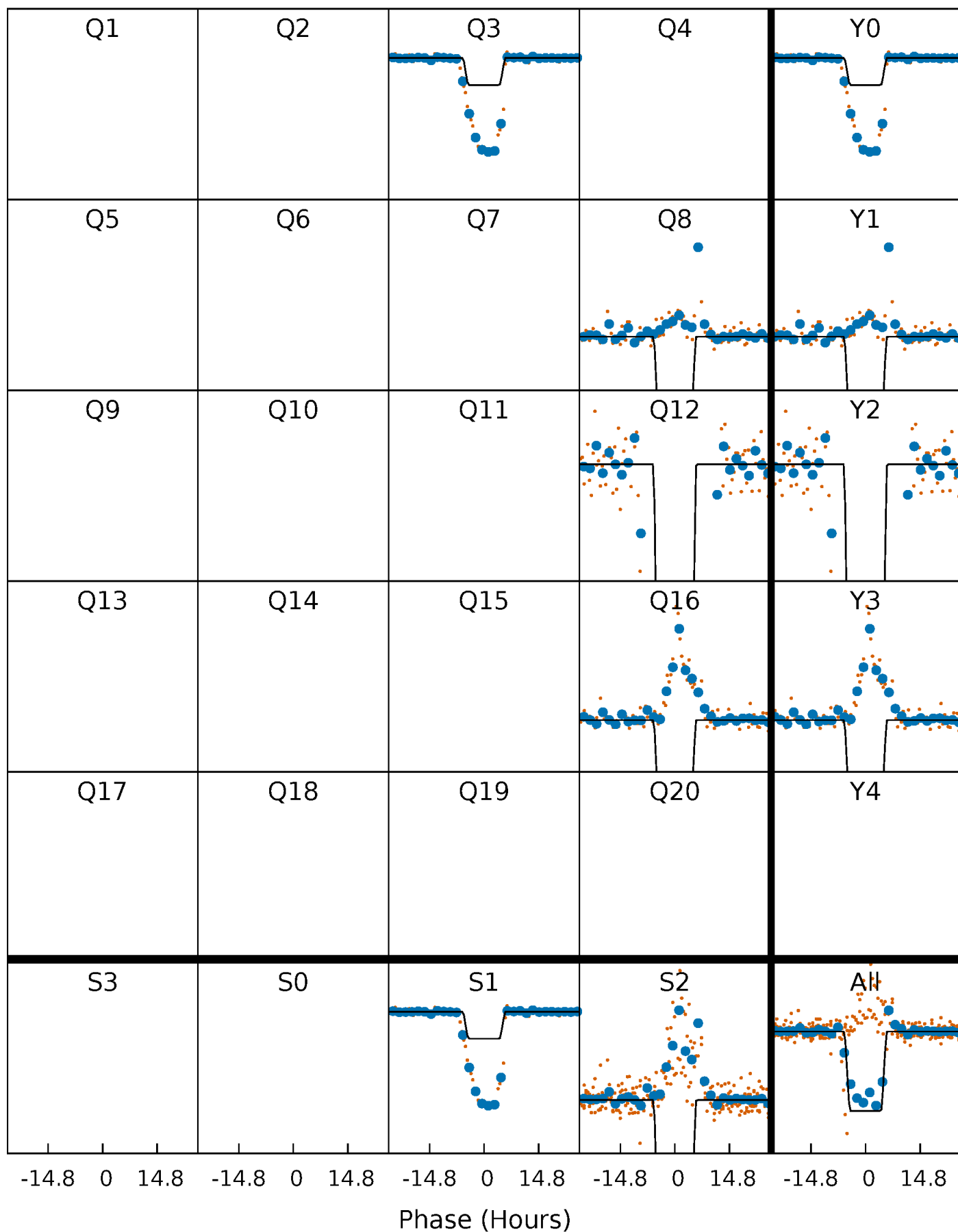
# DV Quarter-Phased Transit Curves

TCE 002987160-03     $P=395.979224$  Days     $T_0=341.823625$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

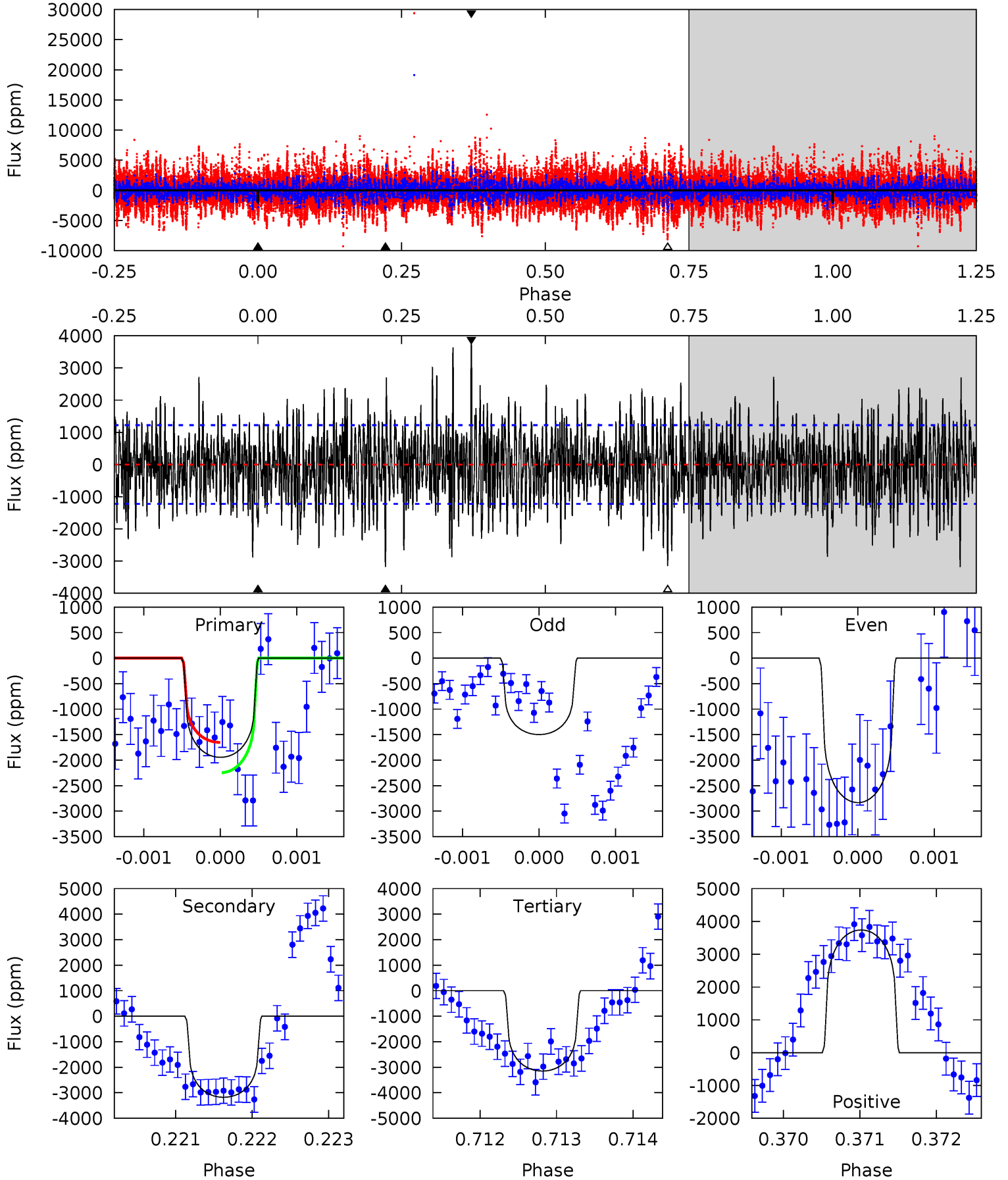
TCE 002987160-03     $P=395.981959$  Days     $T_0=341.817275$  (BKJD)



# DV Model-Shift Uniqueness Test

002987160-03, P = 395.979224 Days, E = 341.823625 Days

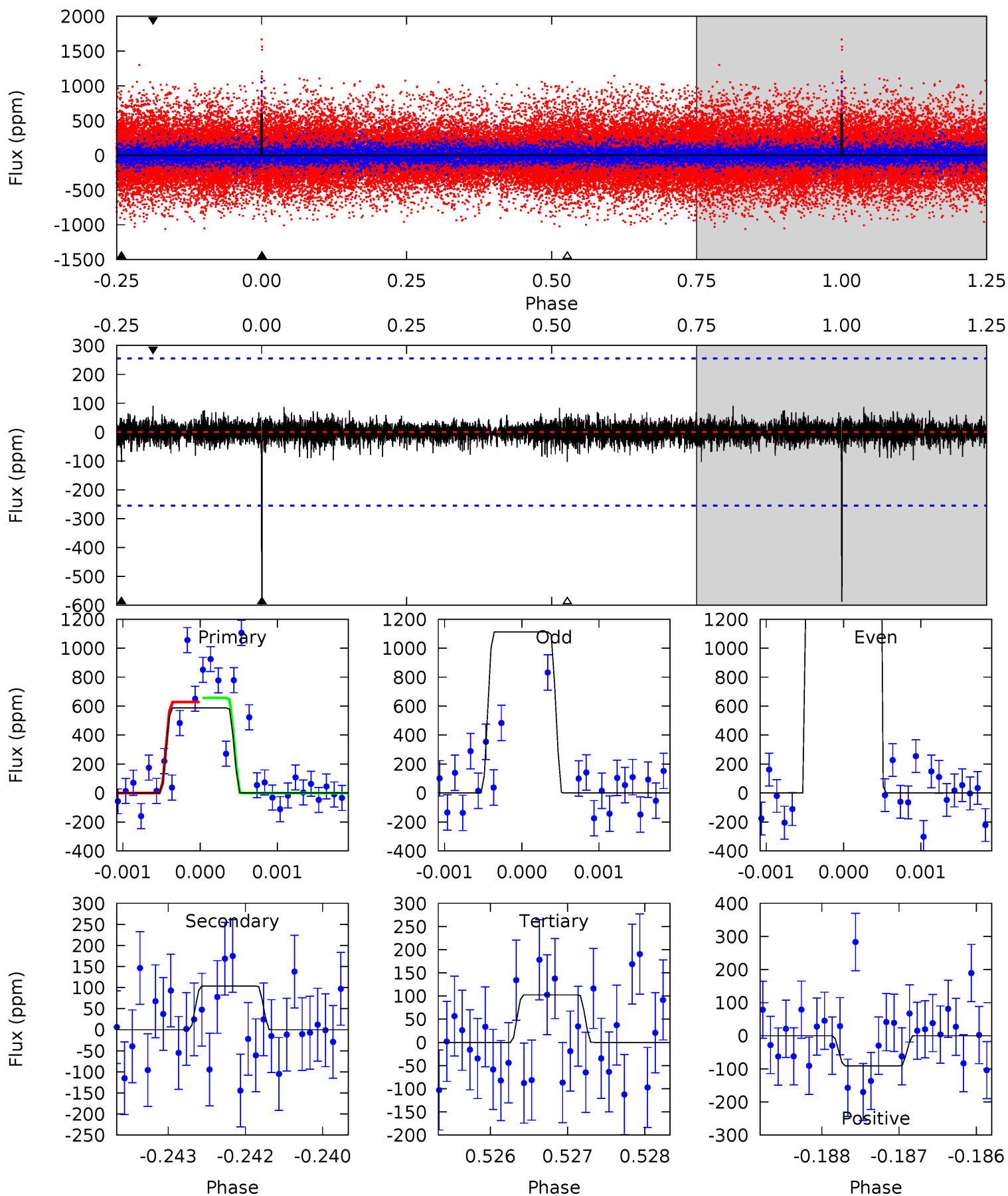
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
8.63	14.1	14.0	16.6	5.43	3.26	4.09	-5.35	-7.97	0.12	-2.50	2.69	0.69	0.54	1.32



# Alt Model-Shift Uniqueness Test

002987160-03, P = 395.981959 Days, E = 341.817275 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
12.5	2.21	2.17	1.93	5.42	3.24	0.43	10.3	10.6	0.03	0.27	173.0	-5.73	0.13	0.31





### Stellar Parameters For KIC 002987160

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R (R_{\odot})$	$M(M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$5551^{+166}_{-166}$	$4.455^{+0.139}_{-0.186}$	$-0.480^{+0.300}_{-0.300}$	$0.844^{+0.182}_{-0.121}$	$0.742^{+0.118}_{-0.047}$	$1.738^{+1.037}_{-0.750}$
	+3%/-3%	+3%/-4%	+62%/-62%	+22%/-14%	+16%/-6%	+60%/-43%
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 002987160-03 / KOI

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{\text{max}} (K)$	$T_{\text{obs}} (K)$	$A_{\text{obs}}$
DV	$-3177 \pm 225$	$3.37^{+1.35}_{-1.13}$	$323^{+21}_{-19}$	$6959^{+1810}_{-1046}$	$140885^{+178086}_{-67500}$
Alt.	$-104 \pm 47$	$5.95^{+1.57}_{-1.32}$	$323^{+23}_{-18}$	$2908^{+237}_{-234}$	$1419^{+1189}_{-706}$

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

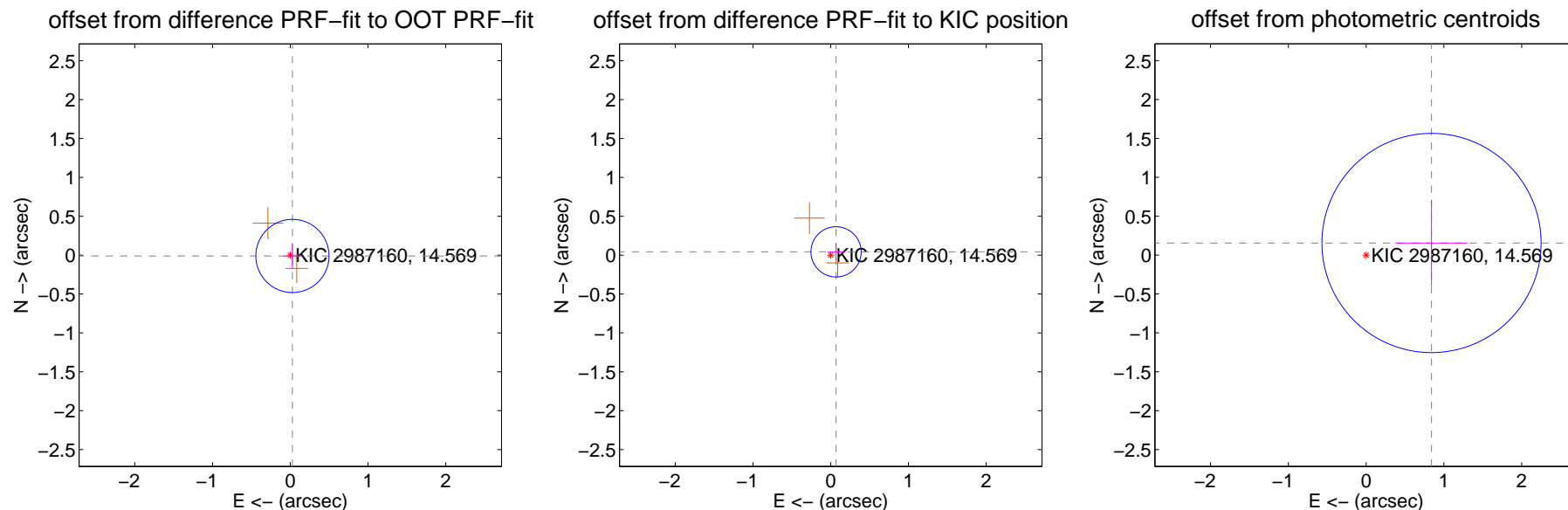
## DV Centroid Data

Supplemental centroid analysis for 002987160-03. Kepler magnitude: 14.57. Transit SNR 4.64

There are 1 quarters with good PRF difference image offsets

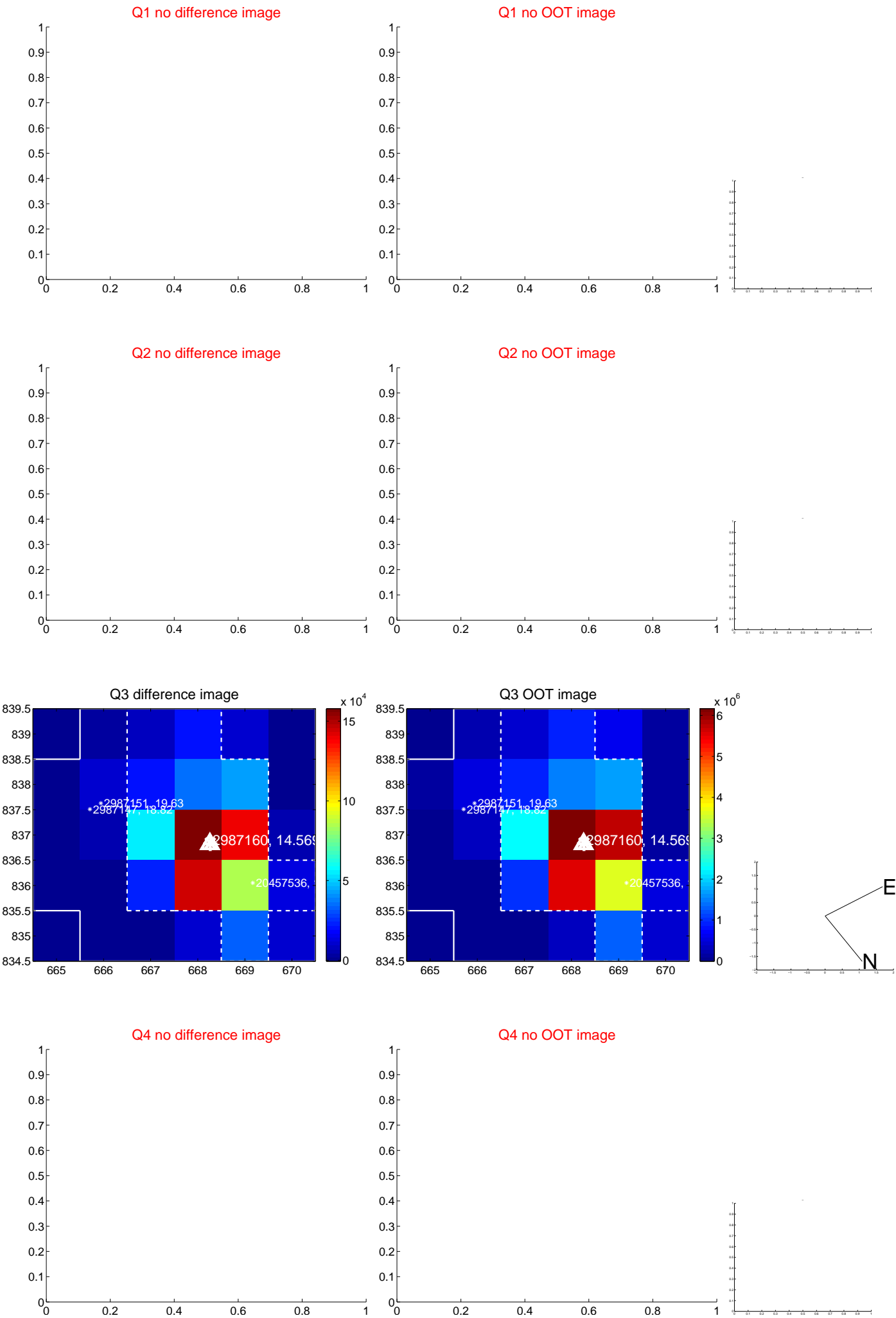
The direct PRF centroid is offset from the target star catalog position by about 0.07 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.030 \pm 0.157$	0.19	$-0.028 \pm 0.118$	$-0.010 \pm 0.161$
PRF-fit source offset from KIC position	$0.081 \pm 0.108$	0.75	$-0.069 \pm 0.105$	$0.042 \pm 0.114$
photometric centroid source offset	$0.85 \pm 0.47$	1.82	$-0.84 \pm 0.47$	$0.16 \pm 0.55$



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.

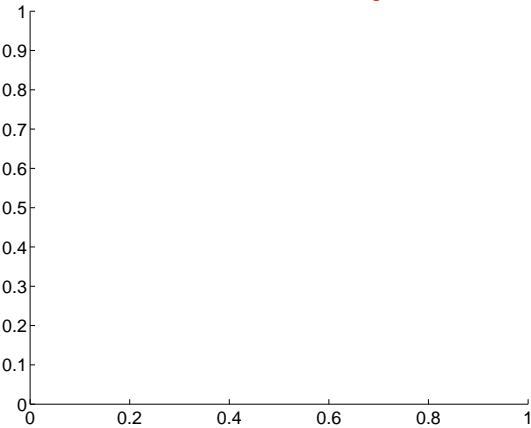
Q5 no difference image



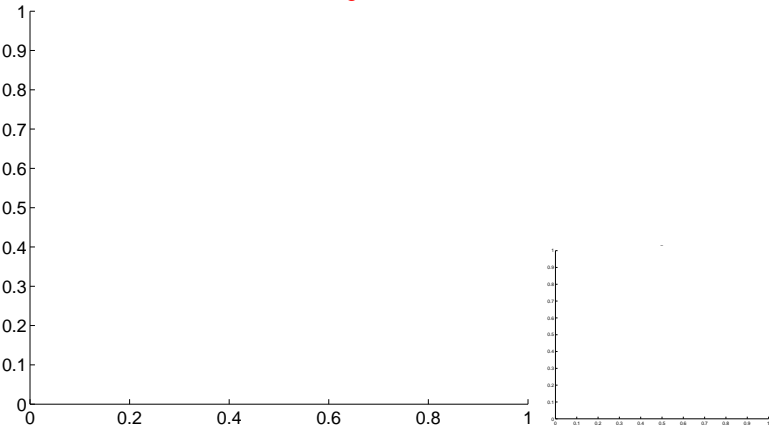
Q5 no OOT image



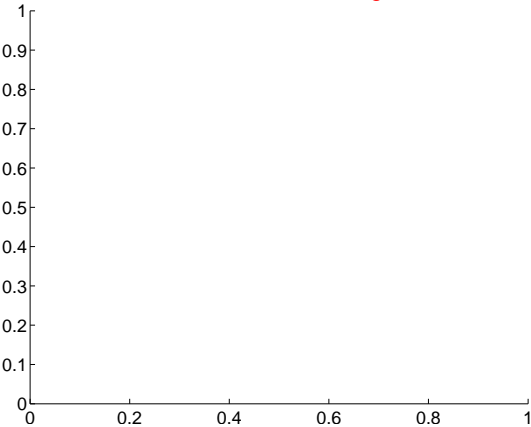
Q6 no difference image



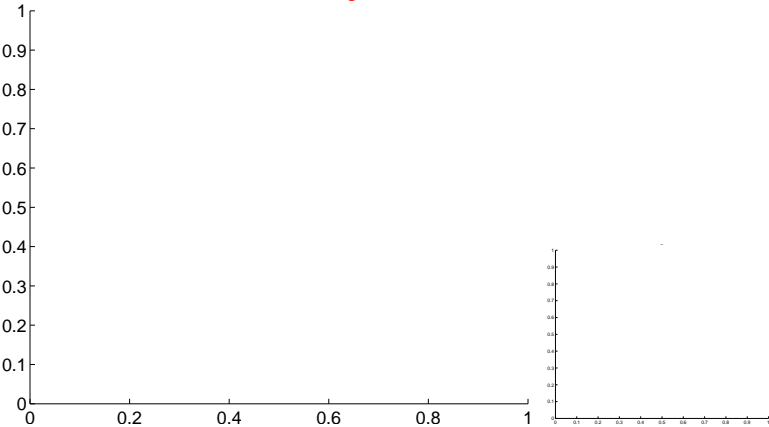
Q6 no OOT image



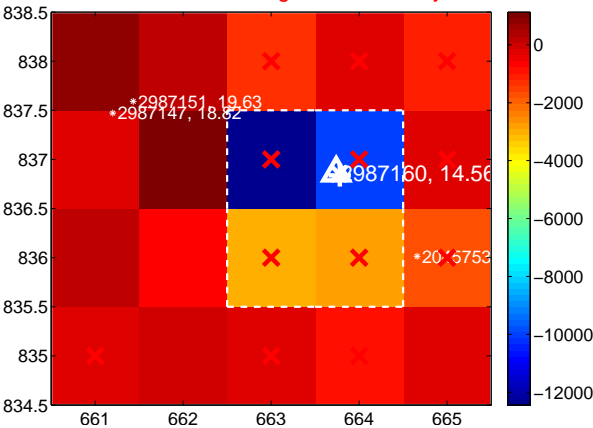
Q7 no difference image



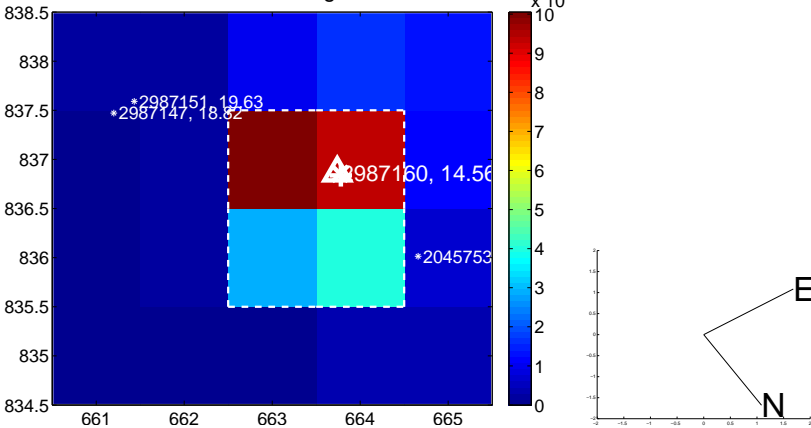
Q7 no OOT image



Q8 difference image. Poor Quality



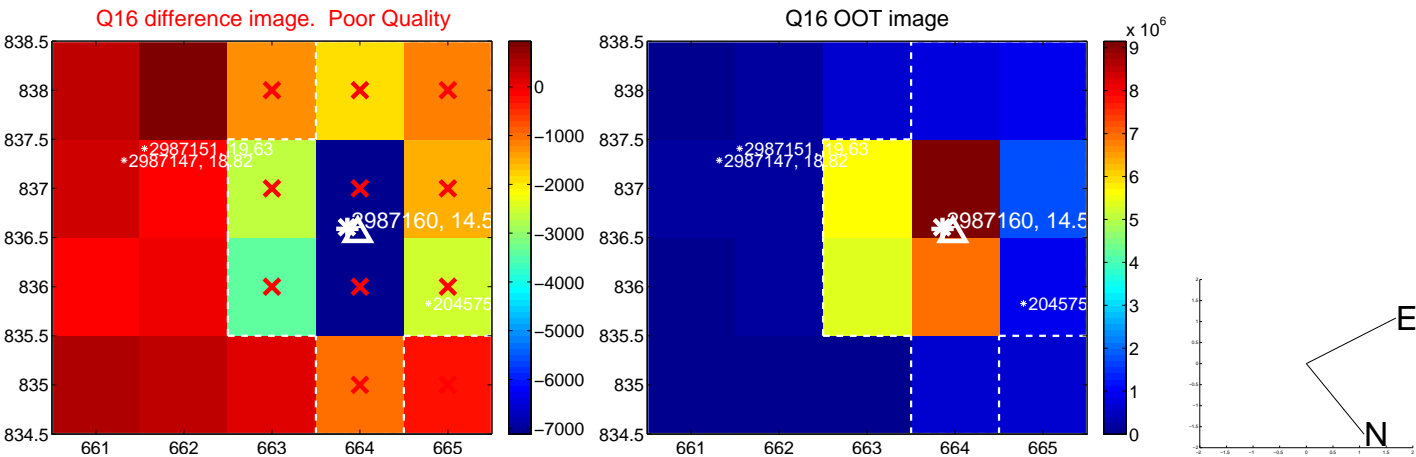
Q8 OOT image



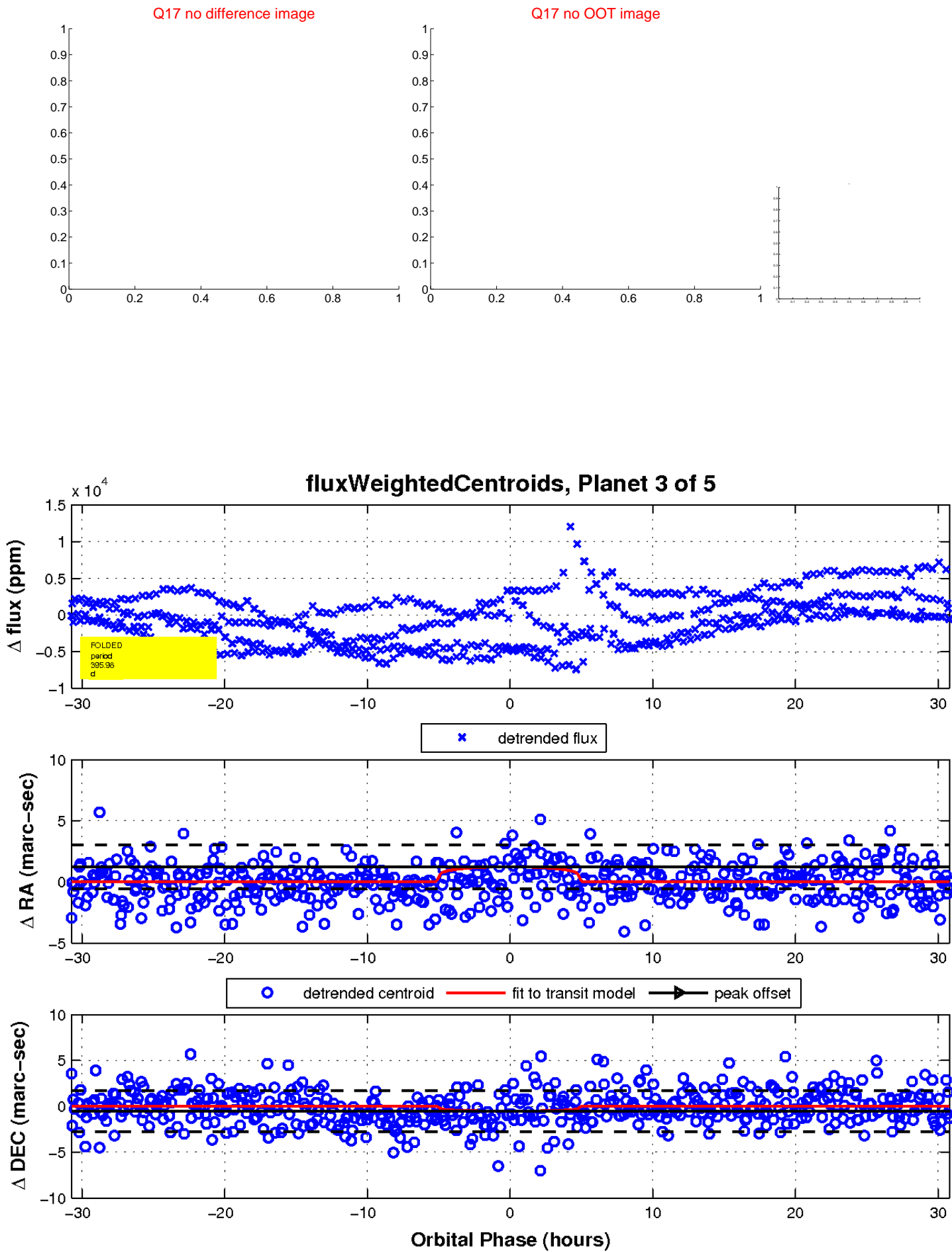
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



white ×: KIC target position; +: OOT centroid; △: difference centroid. red ✕: large negative pixel value.

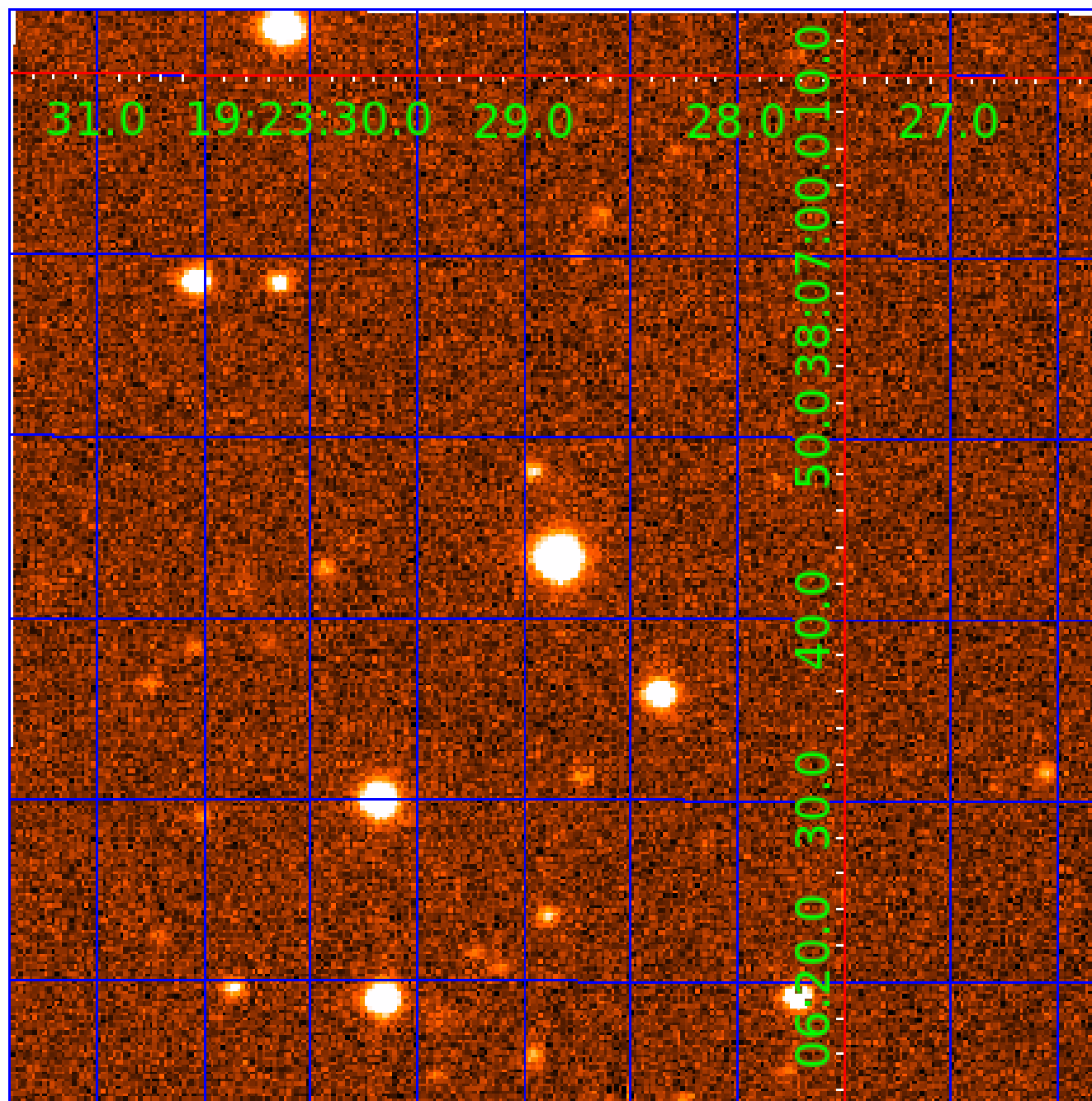


white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



UKIRT Image

Declination





# KIC 002987160

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
002987160-02	OBS	No	331.764796	337.580356	1005.9	3.607	12.8	4.2	0.84	5551	2.66	0.84
002987160-03	OBS	No	395.979225	341.823625	1598.6	10.272	12.0	4.6	0.84	5551	3.34	0.66
002987160-04	OBS	No	369.254809	411.997279	1340.3	2.953	13.8	6.7	0.84	5551	3.17	0.73
002987160-05	OBS	No	349.223163	284.990869	1051.3	6.000	12.5	-1.0	0.84	5551	2.71	0.79

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
002987160-02	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_CHASES_MARSHALL_SKYE—LPP_DV—ALL_TRANS_CHASES—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV—INCONSISTENT_TRANS—CENT_FEW_DIFFS
002987160-03	OBS	FP	0.00	1	0	1	0	LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV—INCONSISTENT_TRANS—CENT_FEW_DIFFS—HALO_GHOST
002987160-04	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_CHASES_MARSHALL—LPP_DV—LPP_ALT—ALL_TRANS_CHASES—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV—CENT_FEW_DIFFS
002987160-05	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_CHASES—LPP_DV—LPP_ALT—ALL_TRANS_CHASES—INCONSISTENT_TRANS—CENT_NOFITS

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

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

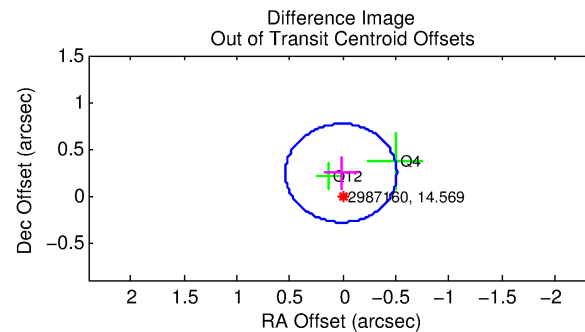
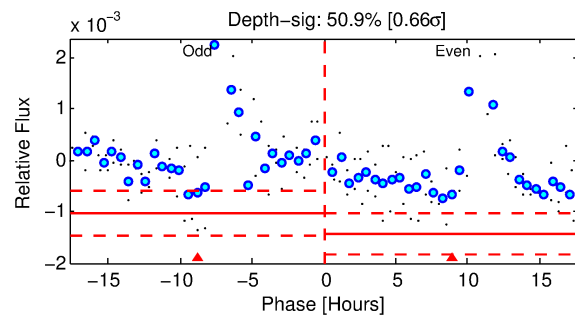
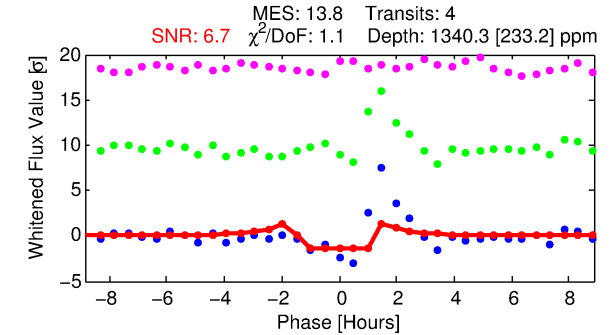
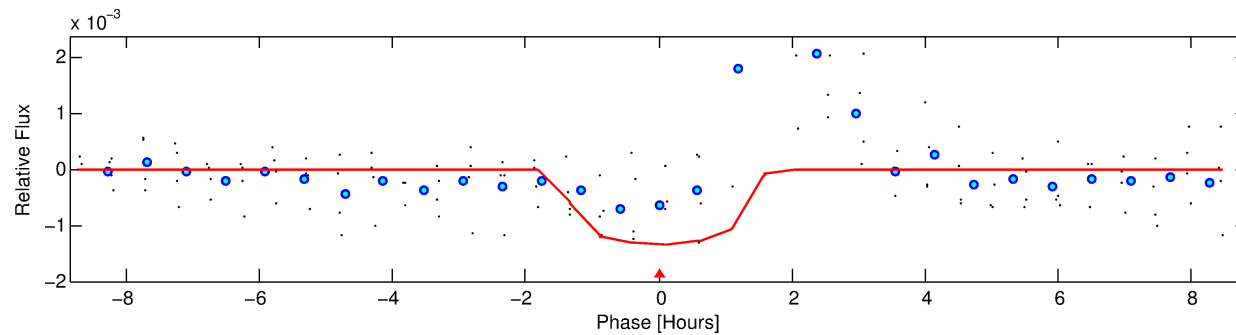
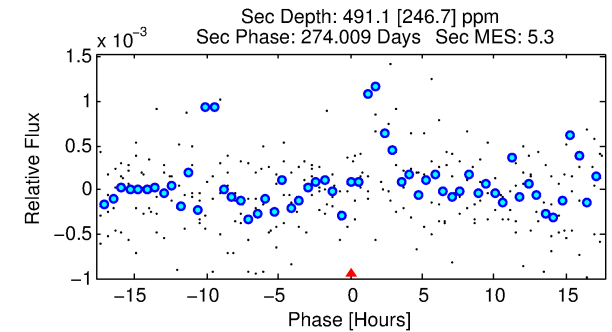
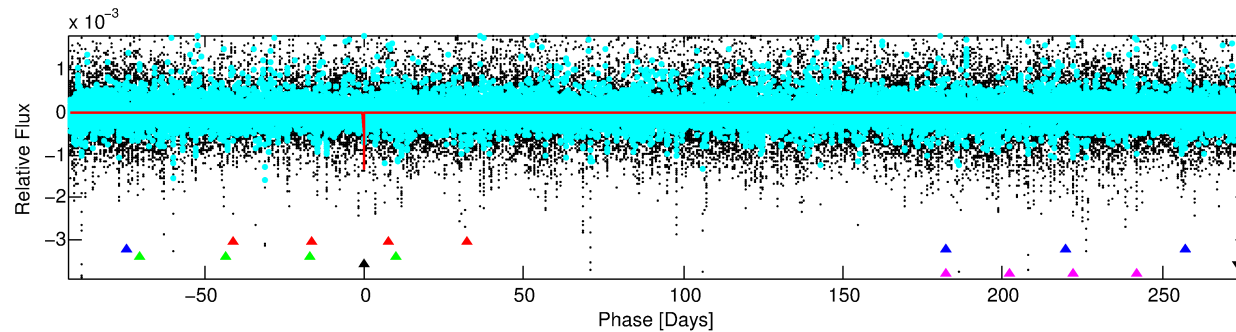
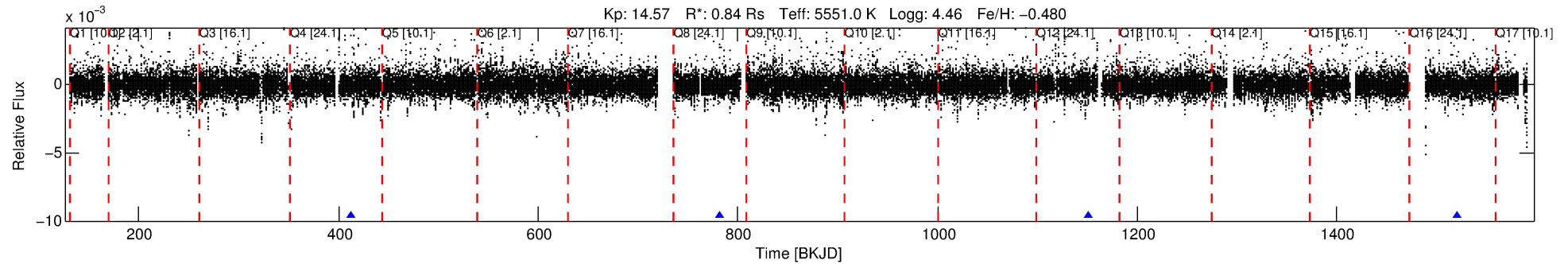
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

Ephemeris Match Information For 002987160-04

No Significant Match Found

# DV One-Page Summary

KIC: 2987160 Candidate: 4 of 5 Period: 369.255 d



## DV Fit Results:

Period = 369.25481 [0.00313] d  
Epoch = 411.9973 [0.0057] BKJD  
Rp/R\* = 0.0344 [0.0931]  
a/R\* = 862.83 [10281.98]  
b = 0.50 [17.85]  
Seff = 0.73 [0.25]  
Teq = 236 [20] K  
Rp = 3.17 [8.60] Re  
a = 0.9116 [0.1847] AU  
Ag = 22411.79 [122165.25] [0.18σ]  
Teffp = 4458 [6065] K [0.70σ]

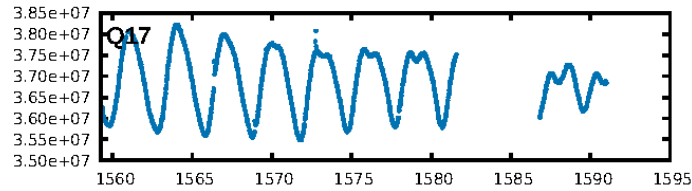
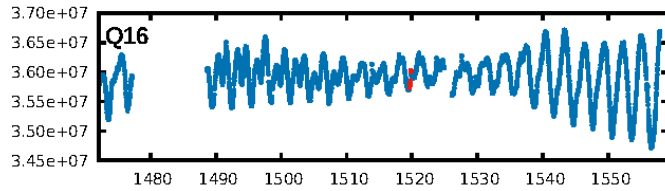
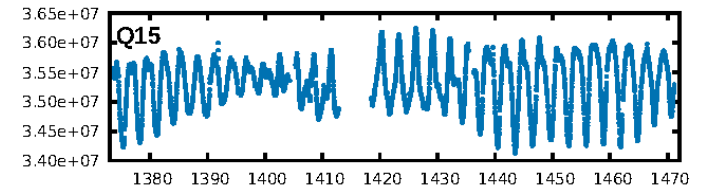
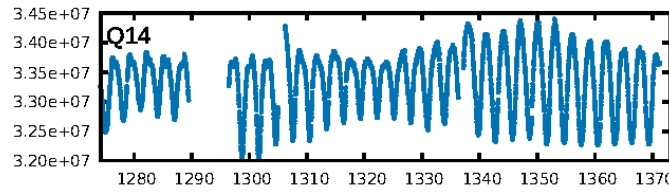
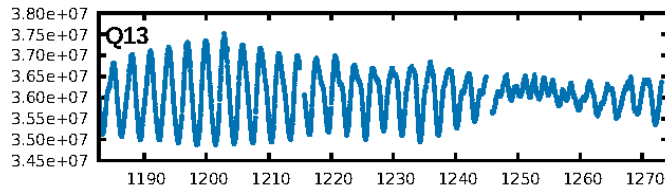
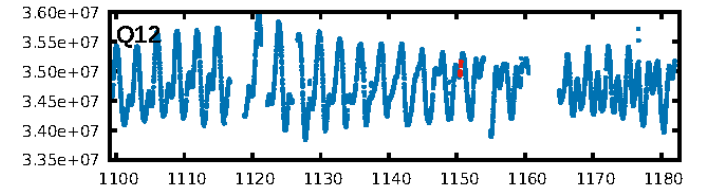
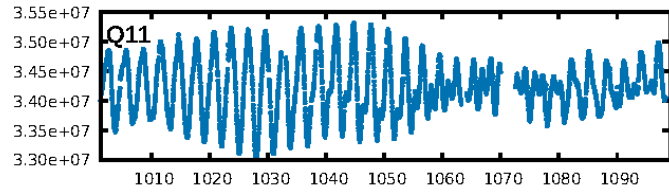
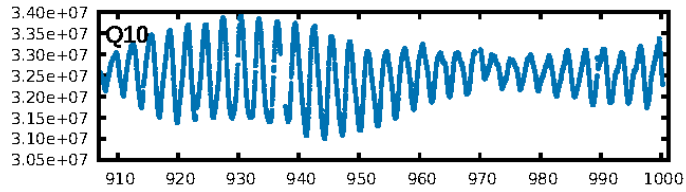
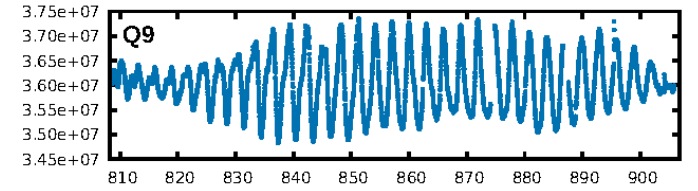
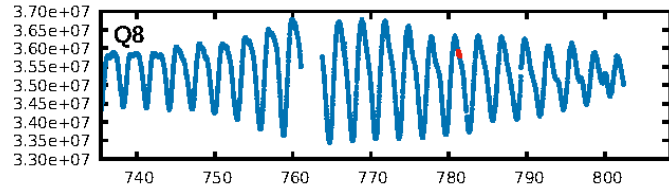
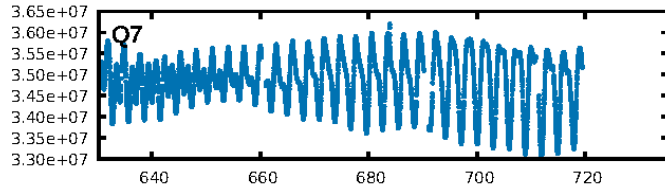
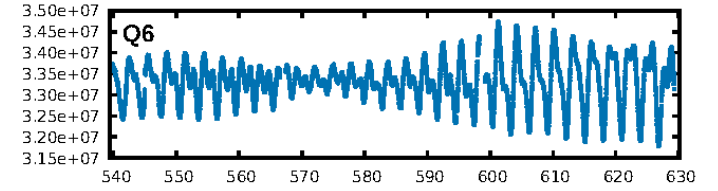
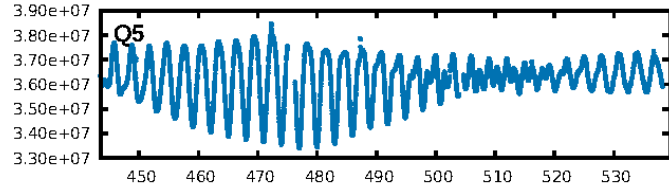
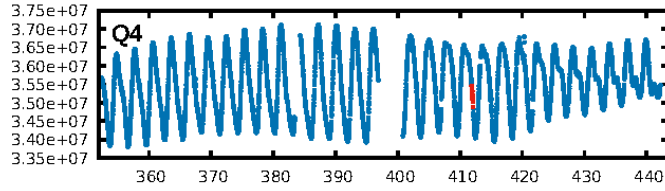
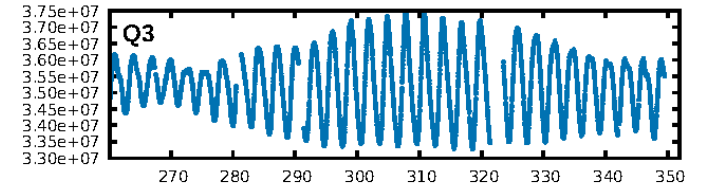
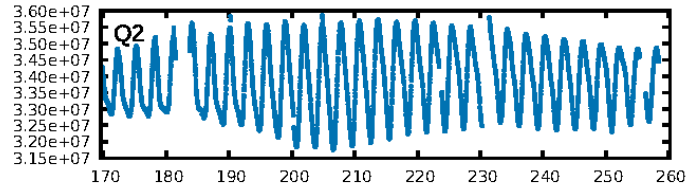
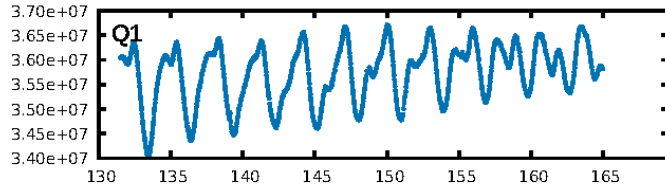
## DV Diagnostic Results:

ShortPeriod-sig: 100.0% [71.89σ]  
LongPeriod-sig: 100.0% [60.01σ]  
ModelChiSquare2-sig: 95.8%  
ModelChiSquareGof-sig: 97.7%  
Bootstrap-pfa: N/A  
RollingBand-fgt: 1.00 [4/4]  
GhostDiagnostic-chr: -469.6  
Centroid-sig: 17.9%  
Centroid-so: 0.947 arcsec [1.22σ]  
OotOffset-rm: 0.242 arcsec [1.38σ]  
OotOffset-st: 0/0/2/0 [2]  
KicOffset-rm: 0.338 arcsec [1.93σ]  
KicOffset-st: 0/0/2/0 [2]  
DiffImageQuality-fgm: 0.50 [1/2]  
DiffImageOverlap-fno: 1.00 [4/4]

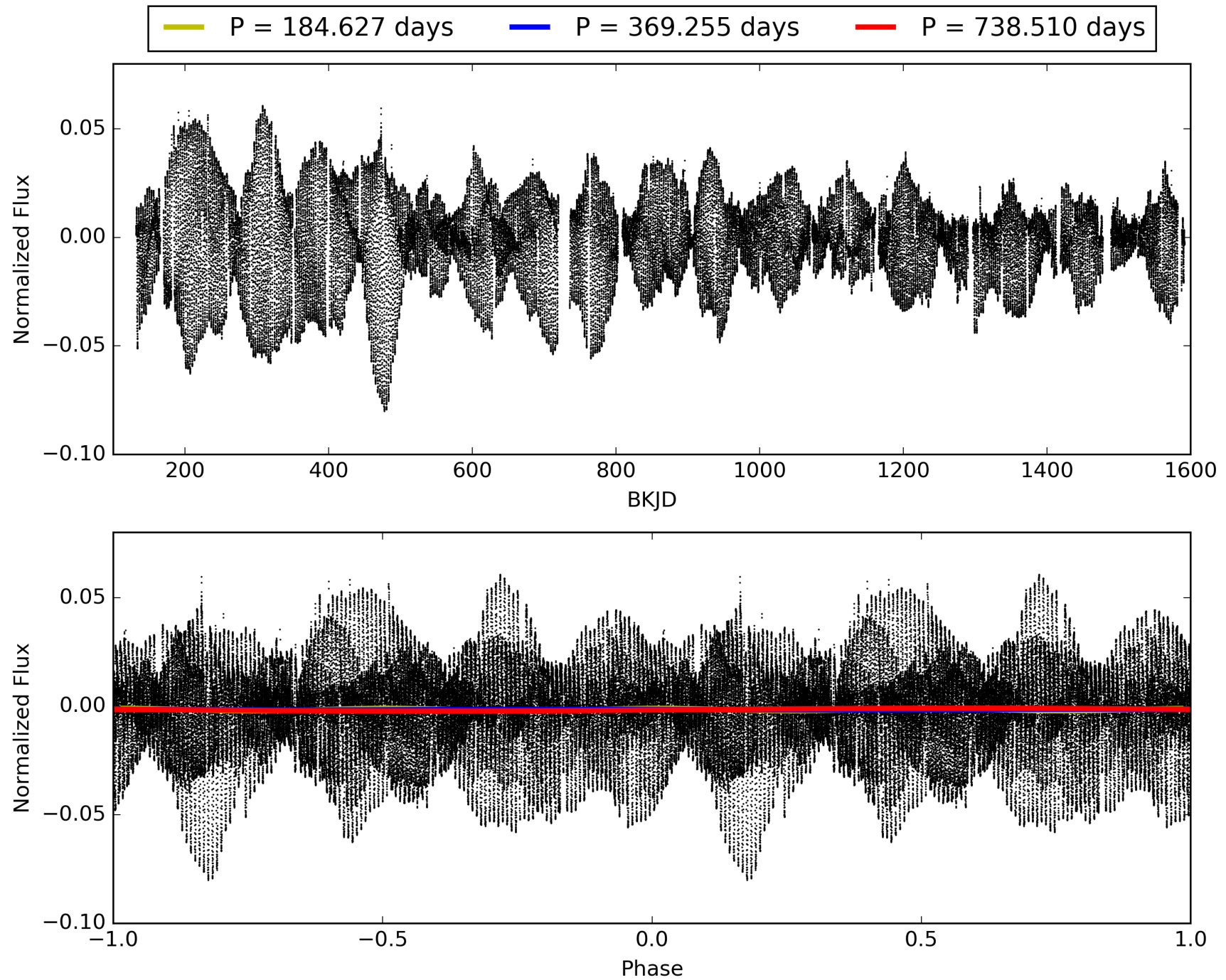
Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 03-Feb-2016 07:57:50 Z

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

# TCE 002987160-04, PDC Light Curves

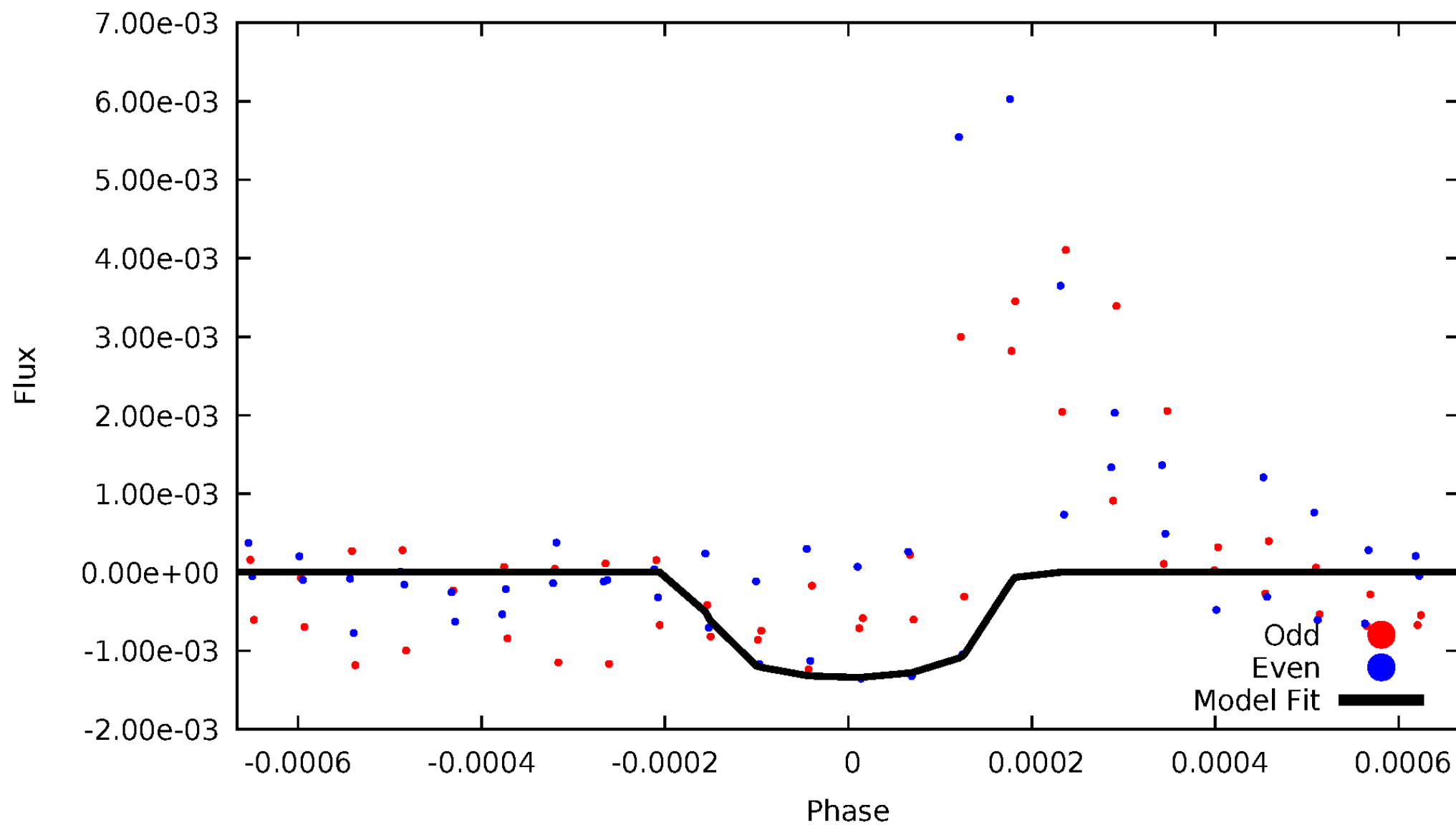


TCE 002987160-04



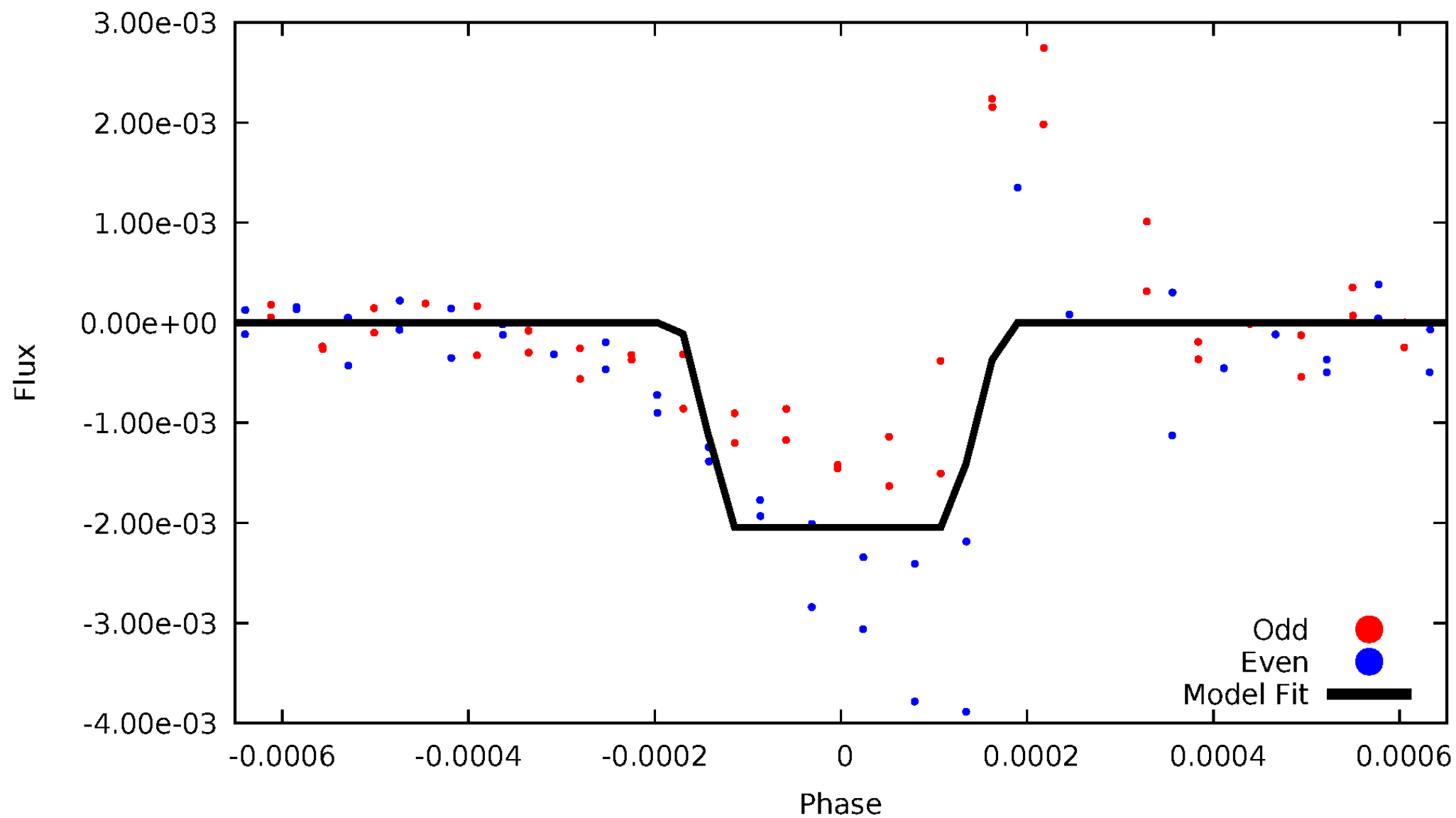
# DV Odd/Even

TCE 002987160-04



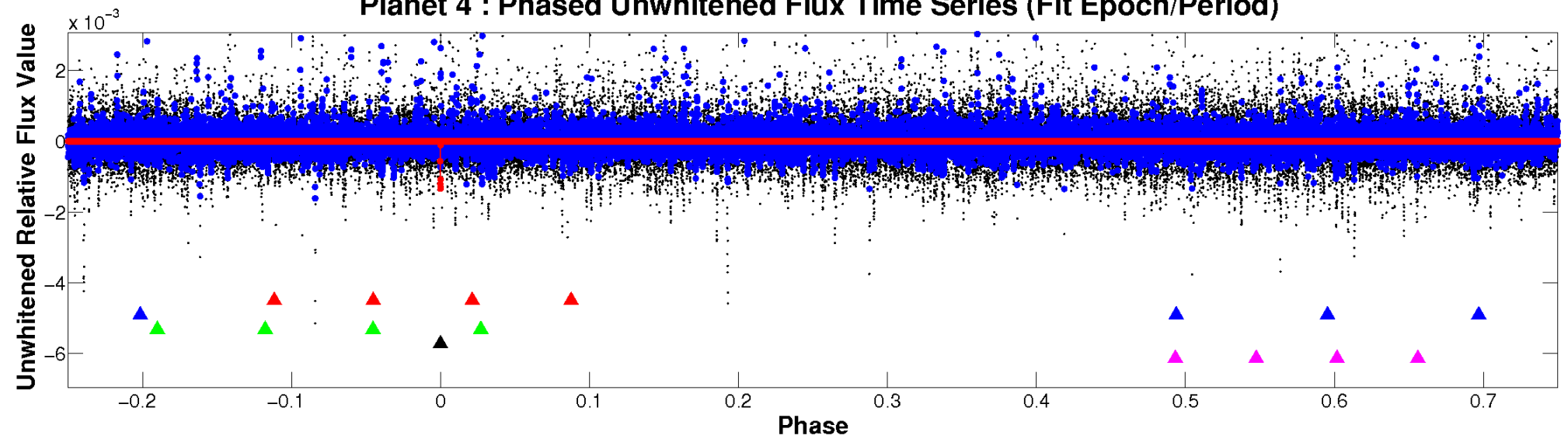
# ALT Odd/Even

TCE 002987160-04

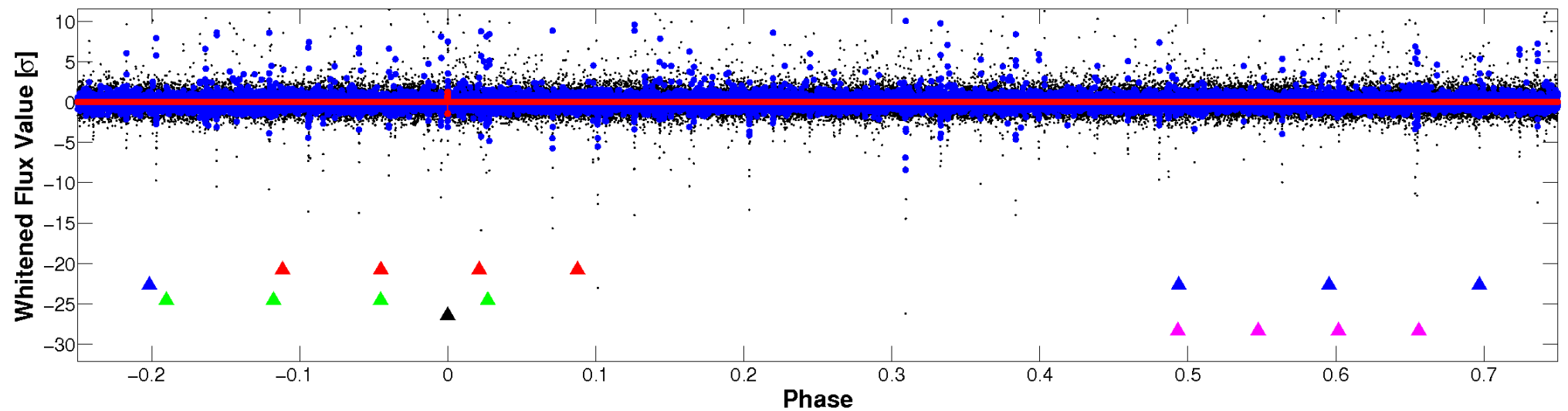


# Non-Whitened Vs. Whitened Light Curve

## Planet 4 : Phased Unwhitened Flux Time Series (Fit Epoch/Period)

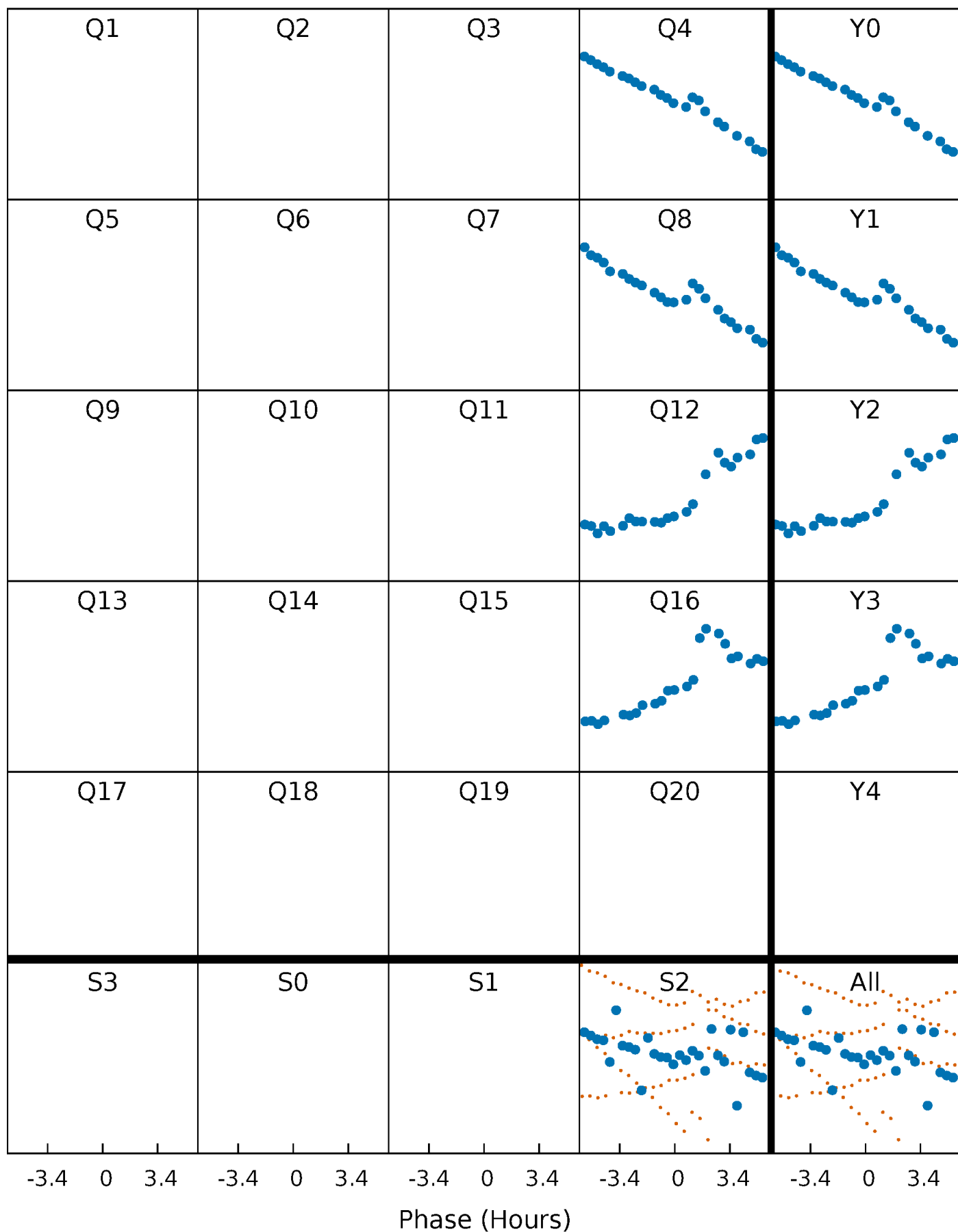


## Planet 4 : Phased Whitened Flux Time Series (Fit Epoch/Period)



# PDC Quarter-Phased Transit Curves

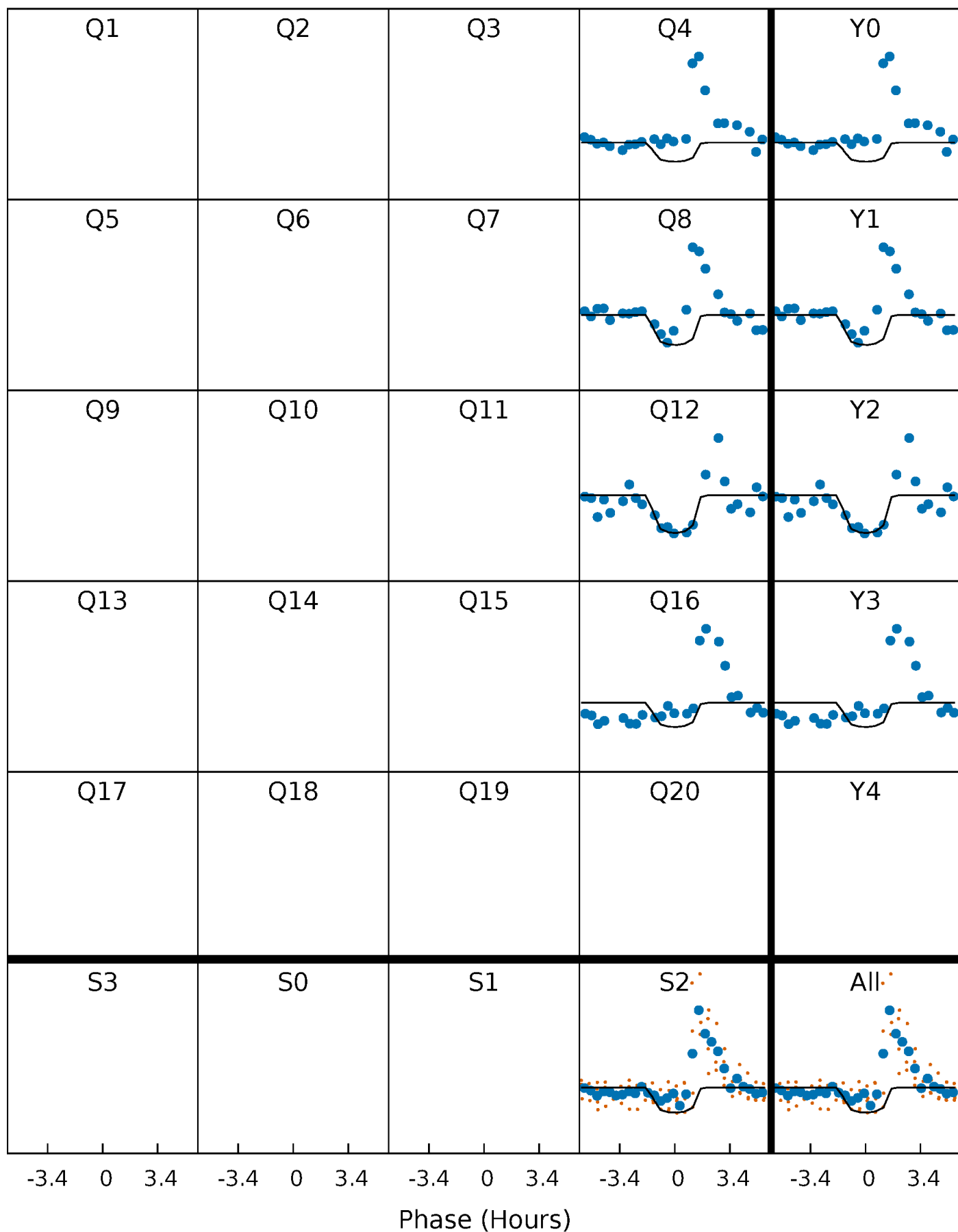
TCE 002987160-04 P=369.254809 Days  $T_0=411.997279$  (BKJD)





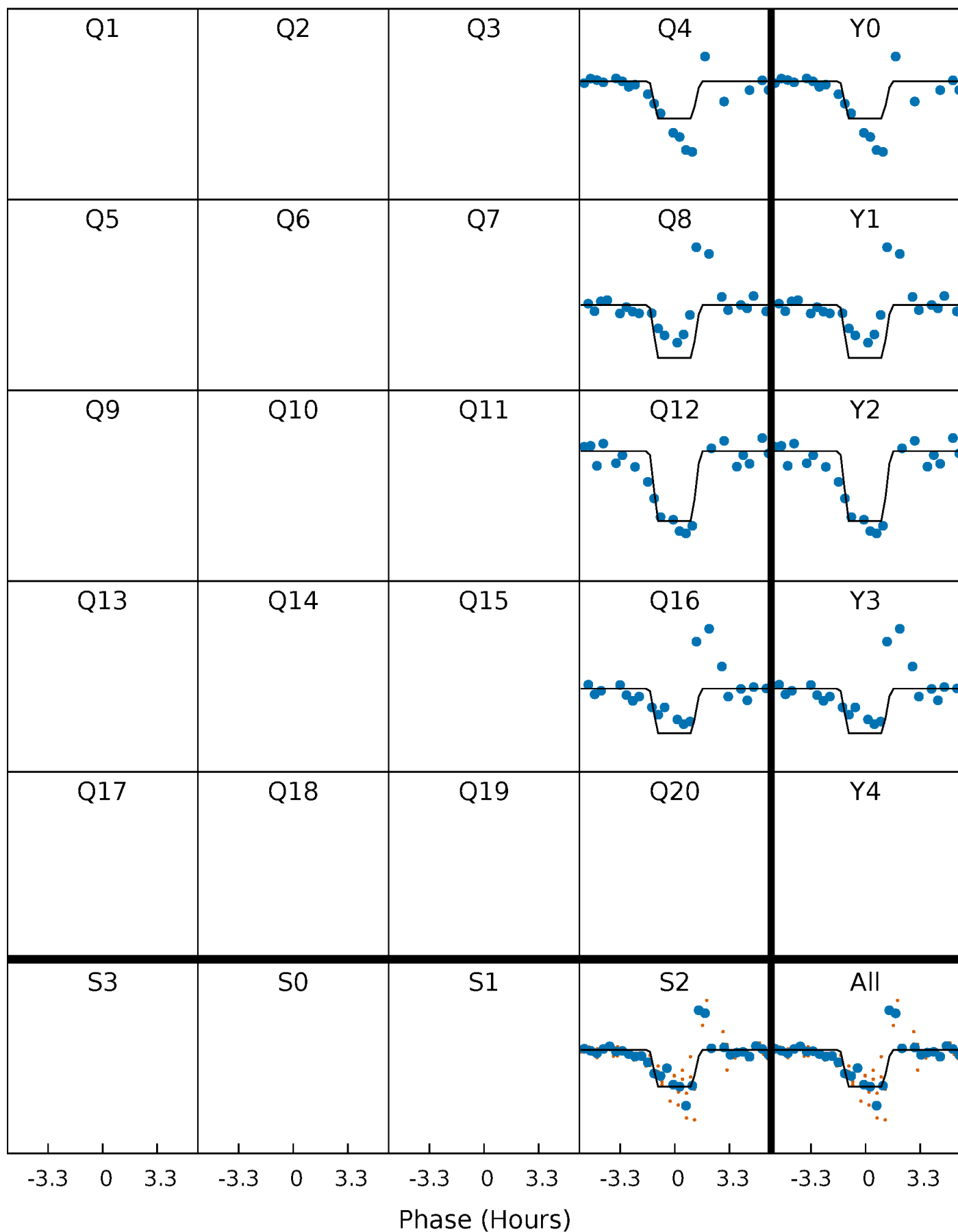
# DV Quarter-Phased Transit Curves

TCE 002987160-04     $P=369.254809$  Days     $T_0=411.997279$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

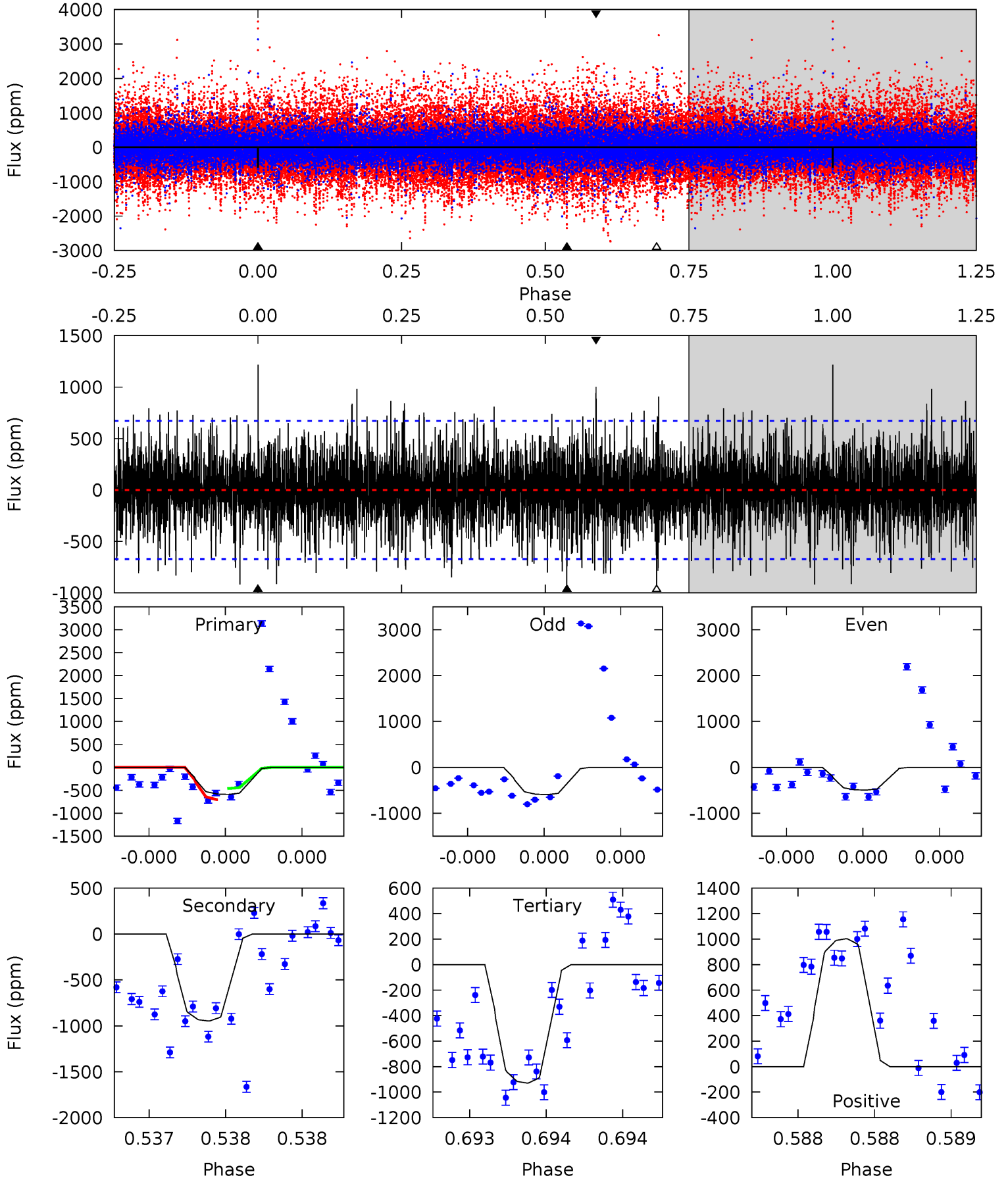
TCE 002987160-04 P=369.265688 Days  $T_0=411.971700$  (BKJD)



# DV Model-Shift Uniqueness Test

002987160-04, P = 369.254809 Days, E = 42.742470 Days

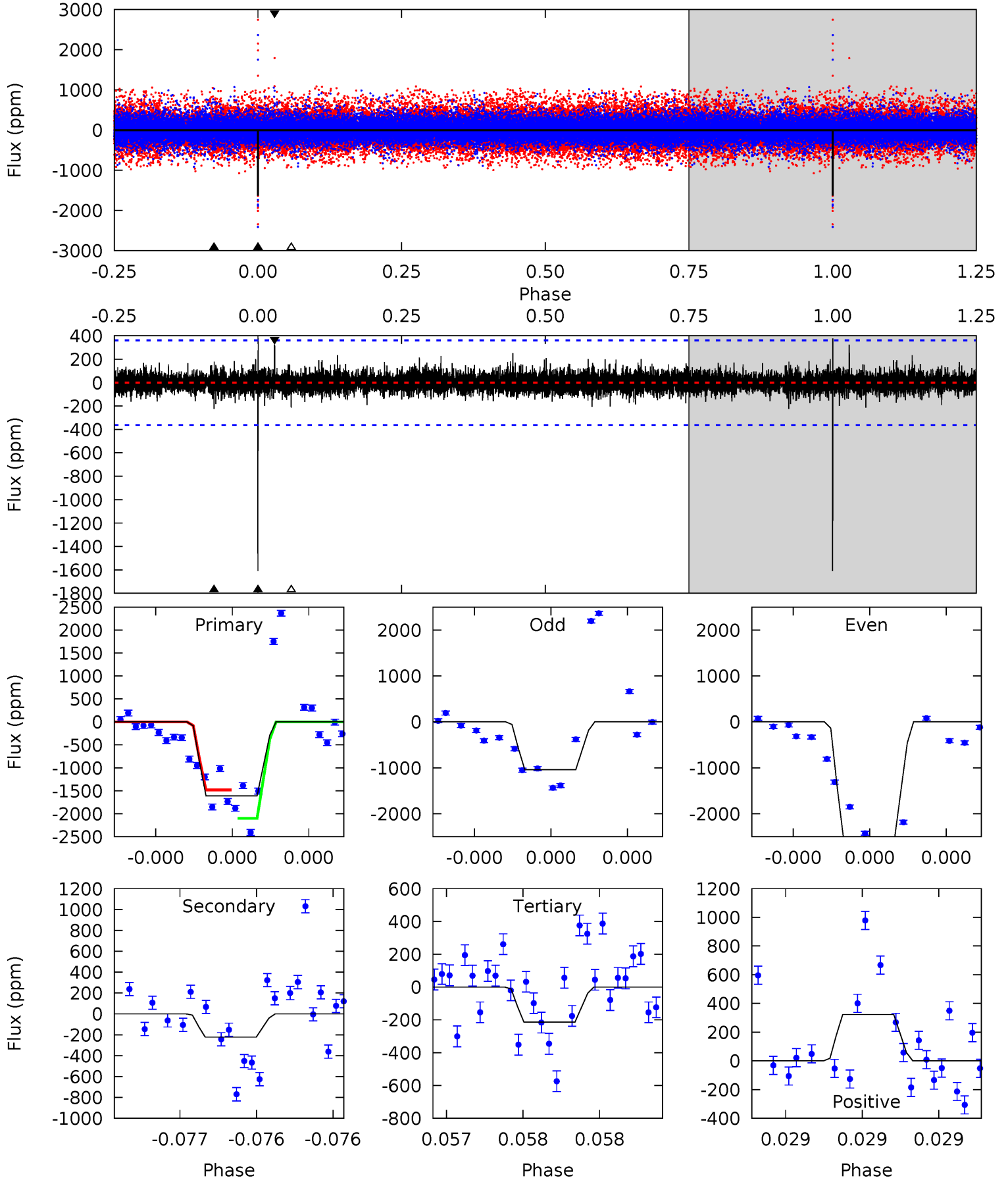
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
4.93	7.93	7.78	8.40	5.62	3.55	1.98	-2.84	-3.46	0.16	-0.46	0.39	0.52	0.56	1.02



# Alt Model-Shift Uniqueness Test

002987160-04, P = 369.265688 Days, E = 42.706012 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
25.1	3.47	3.34	5.04	5.64	3.59	0.73	21.8	20.1	0.13	-1.57	13.6	1.07	0.19	4.61



### Stellar Parameters For KIC 002987160

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R (R_{\odot})$	$M(M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$5551^{+166}_{-166}$	$4.455^{+0.139}_{-0.186}$	$-0.480^{+0.300}_{-0.300}$	$0.844^{+0.182}_{-0.121}$	$0.742^{+0.118}_{-0.047}$	$1.738^{+1.037}_{-0.750}$
	+3%/-3%	+3%/-4%	+62%/-62%	+22%/-14%	+16%/-6%	+60%/-43%
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 002987160-04 / KOI

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{max} (K)$	$T_{obs} (K)$	$A_{obs}$
DV	$-948 \pm 120$	$6.71^{+6.73}_{-4.68}$	$331^{+21}_{-19}$	$3931^{+2623}_{-754}$	$10077^{+103881}_{-7650}$
Alt.	$-222 \pm 64$	$7.05^{+7.90}_{-4.74}$	$330^{+23}_{-18}$	$3073^{+1499}_{-560}$	$1999^{+19224}_{-1556}$

$T_{max}$  = 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

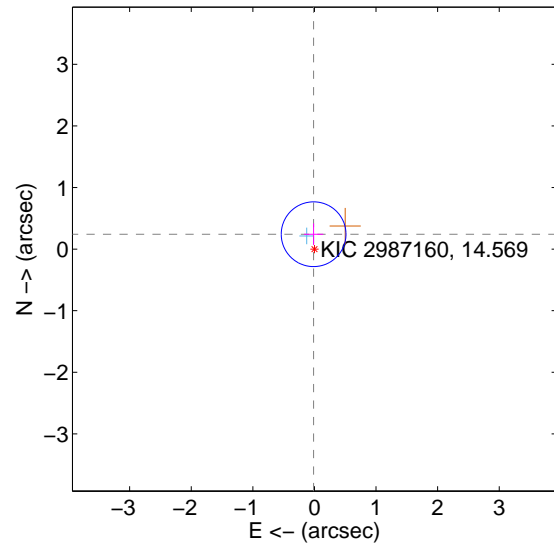
Supplemental centroid analysis for 002987160-04. Kepler magnitude: 14.57. Transit SNR 6.73

There are 1 quarters with good PRF difference image offsets

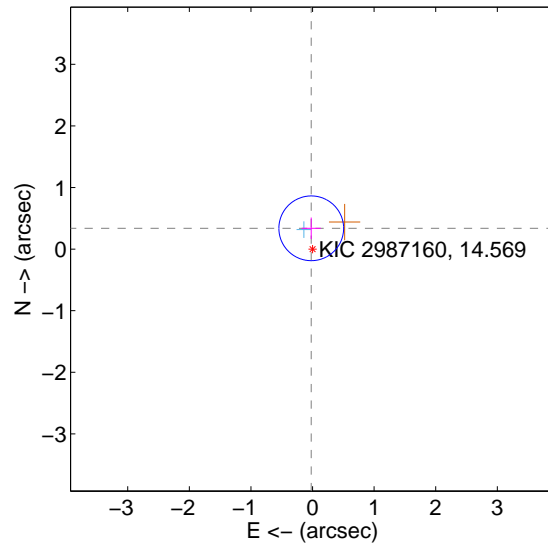
The direct PRF centroid is offset from the target star catalog position by about 0.10 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.242 \pm 0.175$	1.38	$0.013 \pm 0.155$	$0.242 \pm 0.175$
PRF-fit source offset from KIC position	$0.338 \pm 0.175$	1.93	$0.021 \pm 0.155$	$0.338 \pm 0.175$
photometric centroid source offset	$0.95 \pm 0.78$	1.22	$-0.54 \pm 0.81$	$-0.78 \pm 0.76$

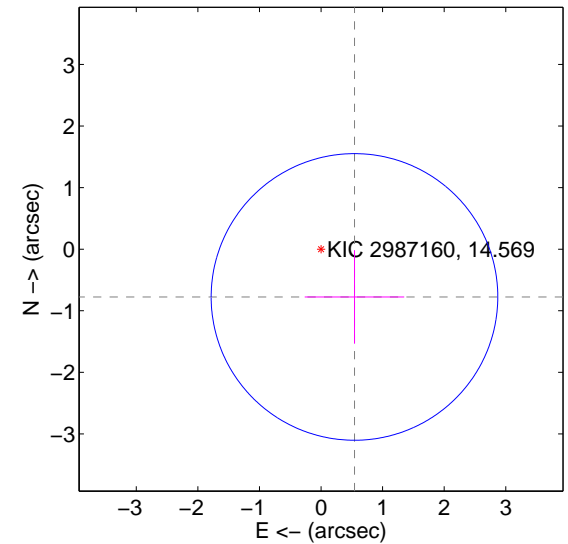
offset from difference PRF-fit to OOT PRF-fit



offset from difference PRF-fit to KIC position

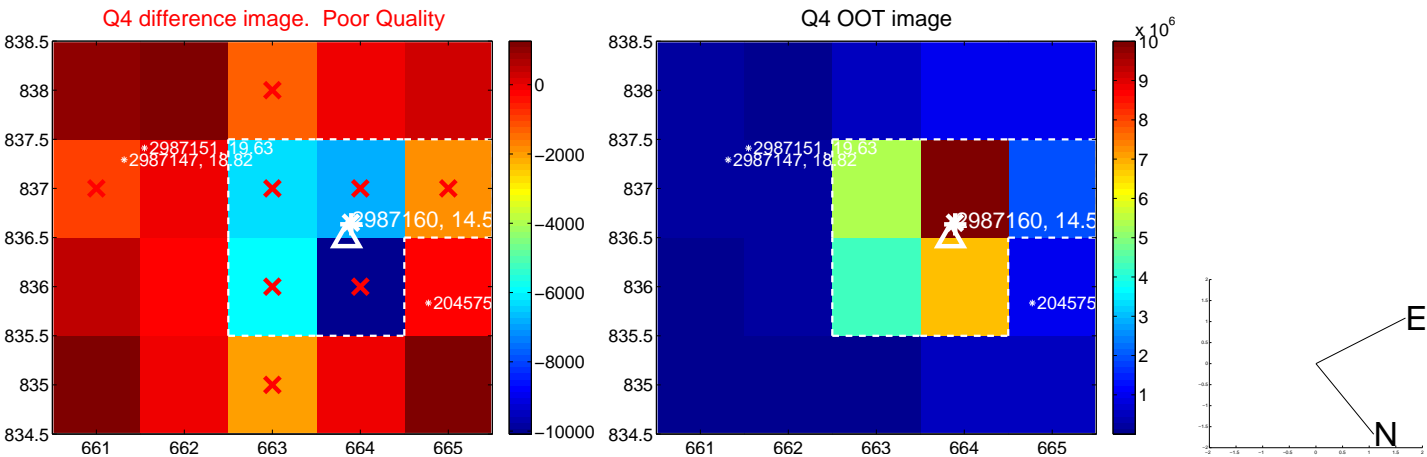


offset from photometric centroids

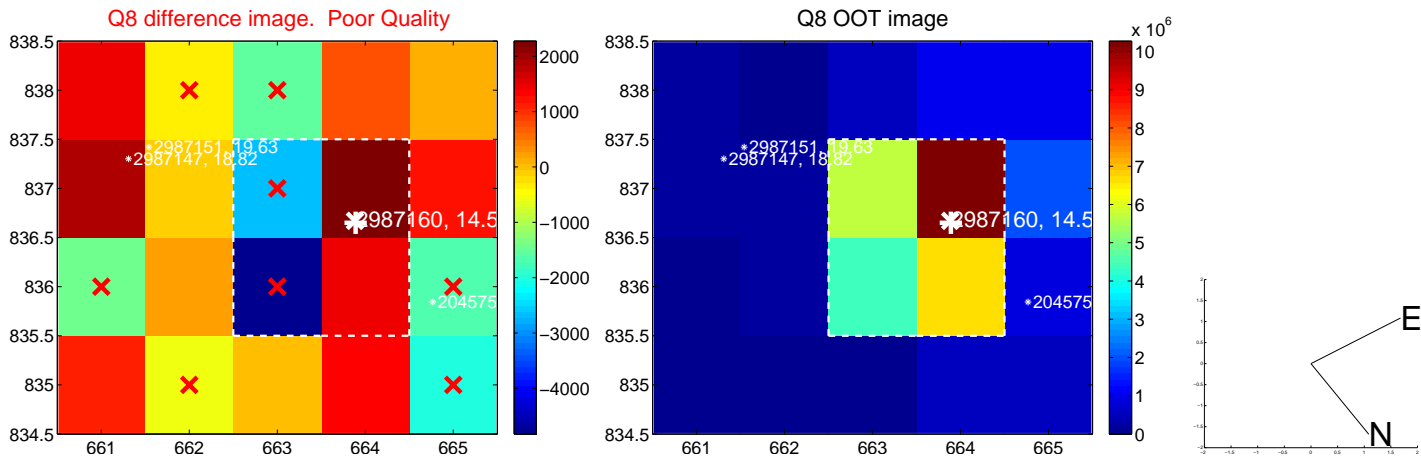


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: three-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

Q9 no difference image



Q9 no OOT image



Q10 no difference image



Q10 no OOT image



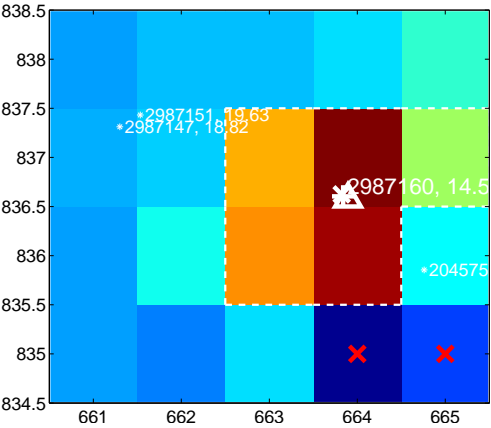
Q11 no difference image



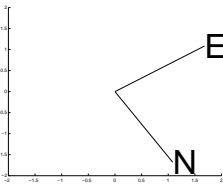
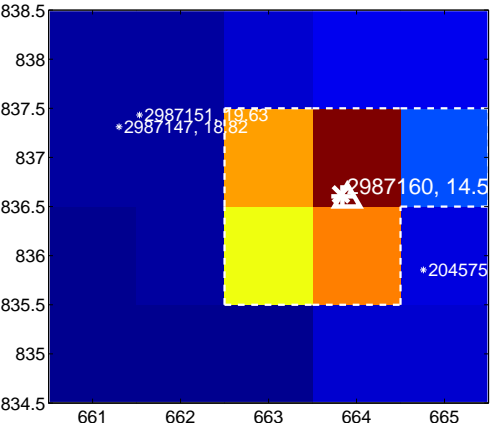
Q11 no OOT image



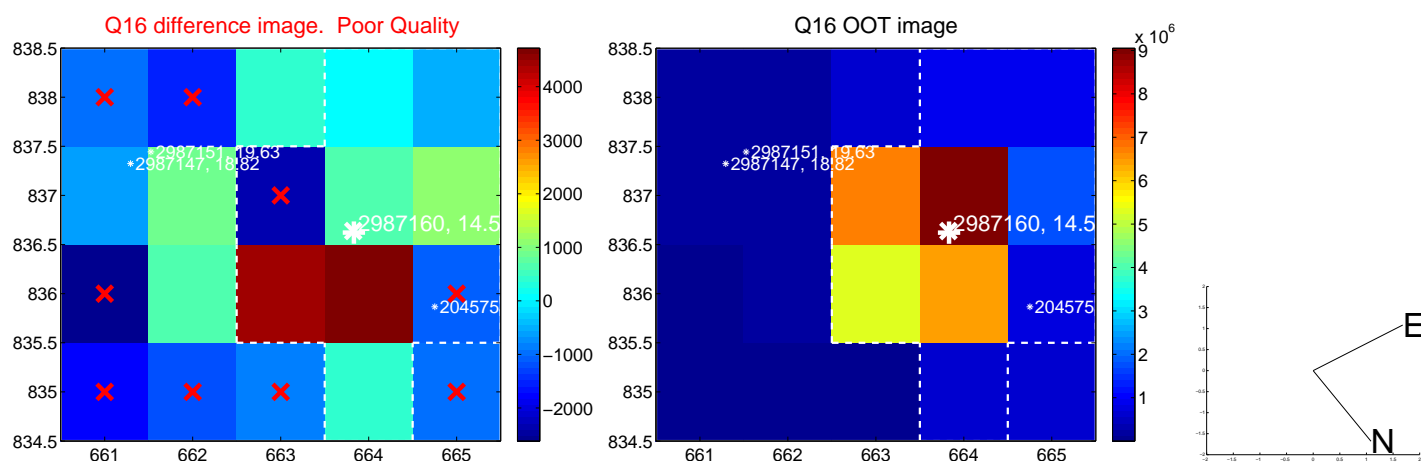
Q12 difference image



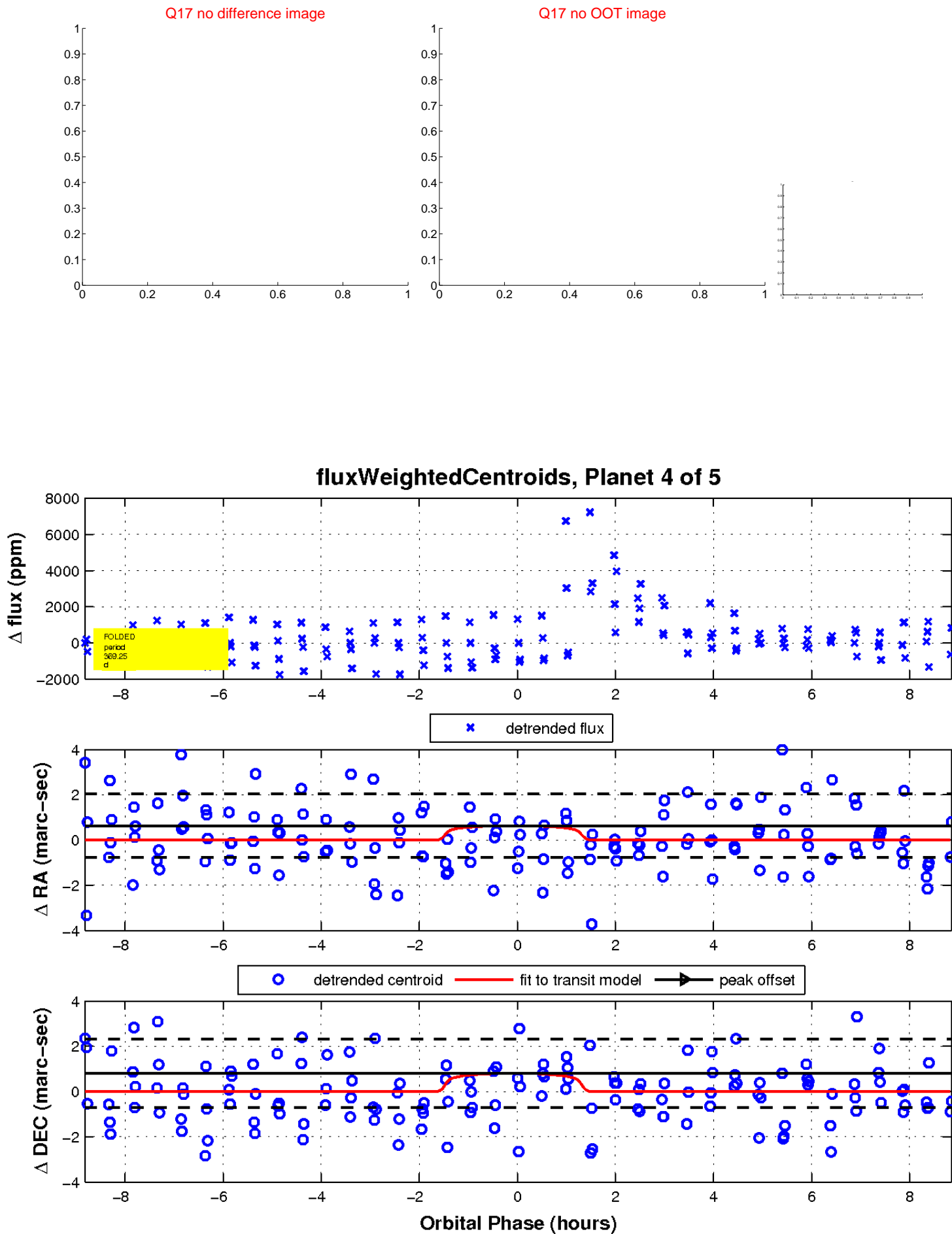
Q12 OOT image



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

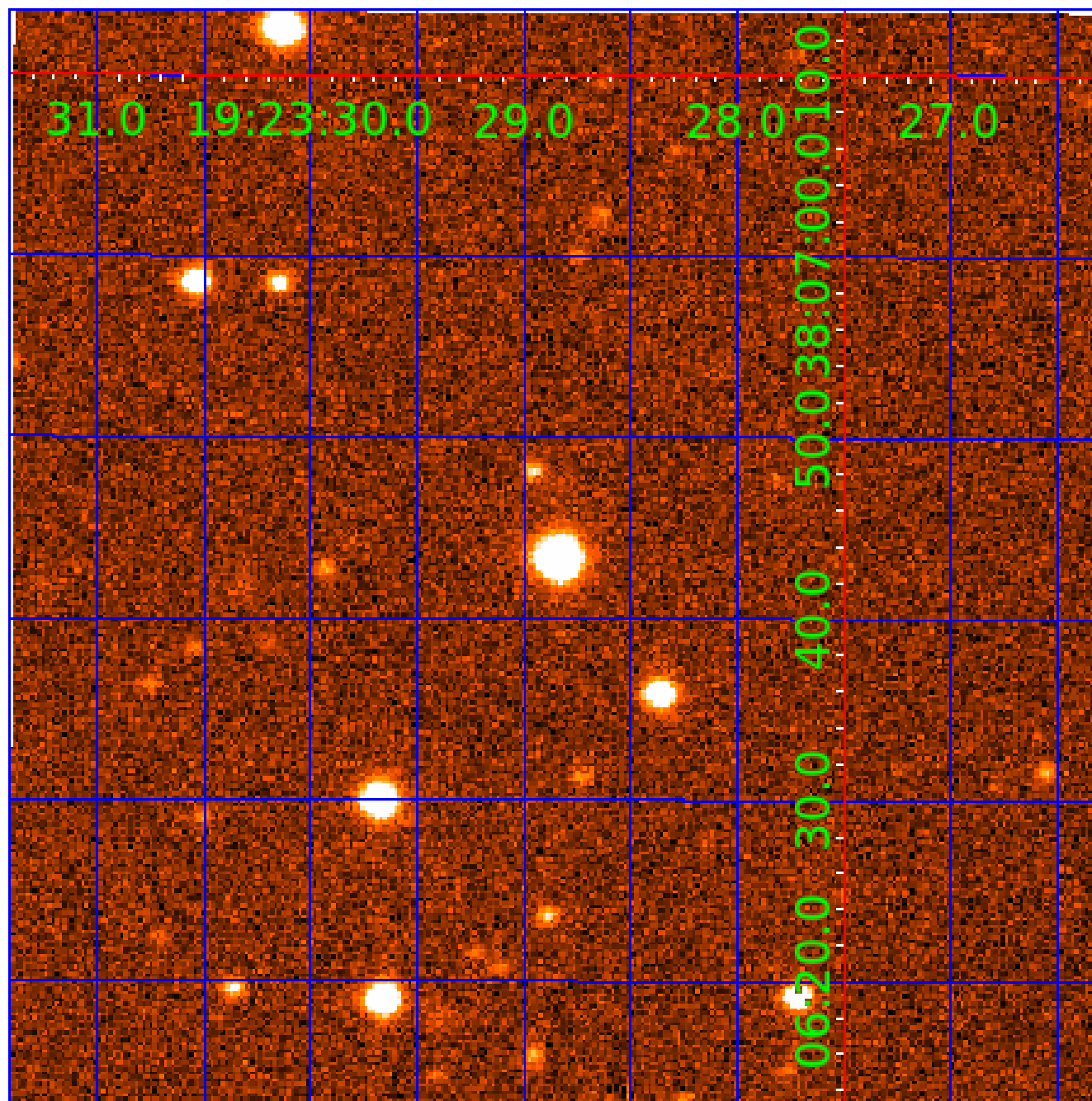


white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



# UKIRT Image

Declination



# KIC 002987160

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
002987160-02	OBS	No	331.764796	337.580356	1005.9	3.607	12.8	4.2	0.84	5551	2.66	0.84
002987160-03	OBS	No	395.979225	341.823625	1598.6	10.272	12.0	4.6	0.84	5551	3.34	0.66
002987160-04	OBS	No	369.254809	411.997279	1340.3	2.953	13.8	6.7	0.84	5551	3.17	0.73
002987160-05	OBS	No	349.223163	284.990869	1051.3	6.000	12.5	-1.0	0.84	5551	2.71	0.79

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
002987160-02	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_CHASES_MARSHALL_SKYE—LPP_DV—ALL_TRANS_CHASES—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV—INCONSISTENT_TRANS—CENT_FEW_DIFFS
002987160-03	OBS	FP	0.00	1	0	1	0	LPP_DV—LPP_ALT—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV—INCONSISTENT_TRANS—CENT_FEW_DIFFS—HALO_GHOST
002987160-04	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_CHASES_MARSHALL—LPP_DV—LPP_ALT—ALL_TRANS_CHASES—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV—CENT_FEW_DIFFS
002987160-05	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_RUBBLE_CHASES—LPP_DV—LPP_ALT—ALL_TRANS_CHASES—INCONSISTENT_TRANS—CENT_NOFITS

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

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

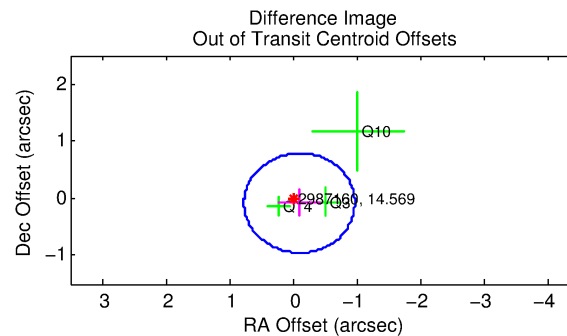
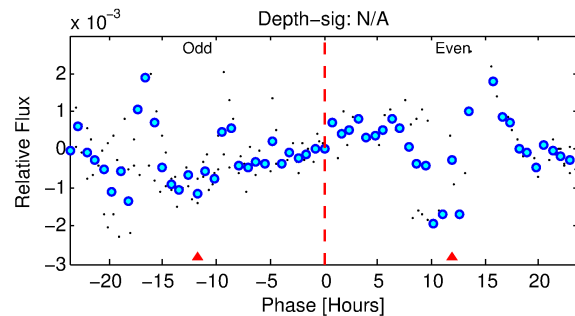
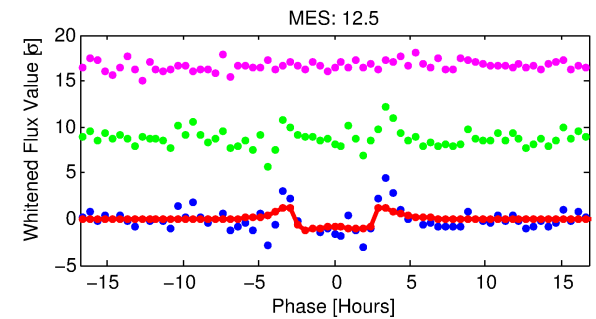
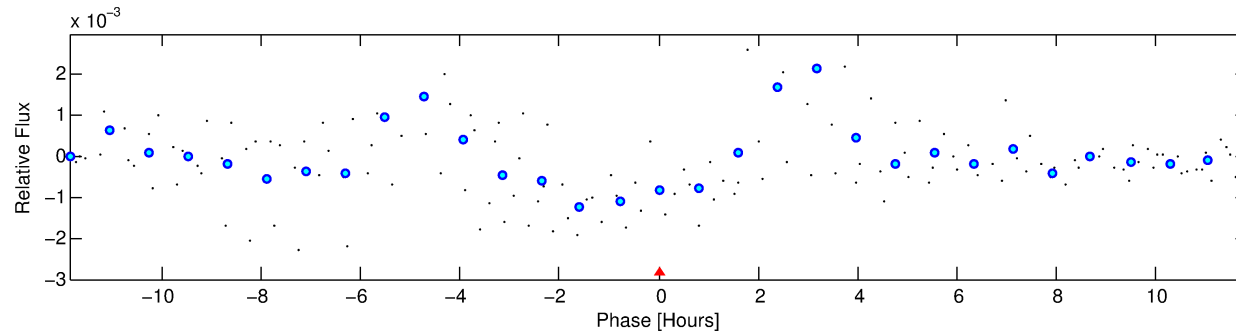
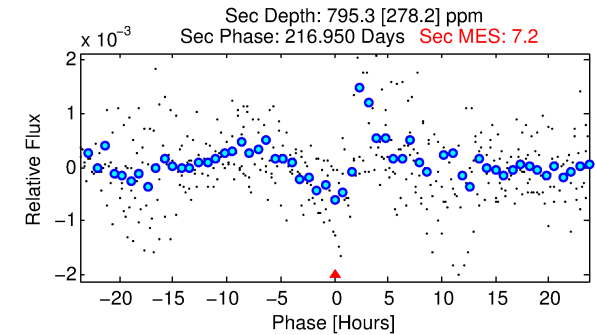
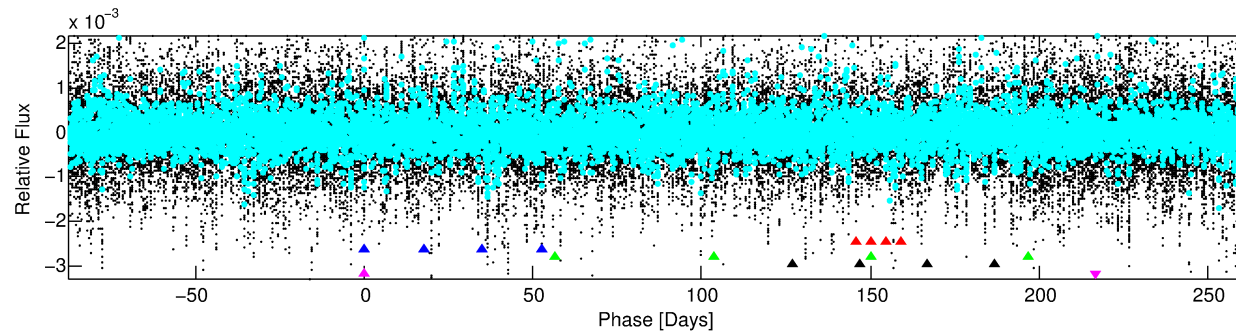
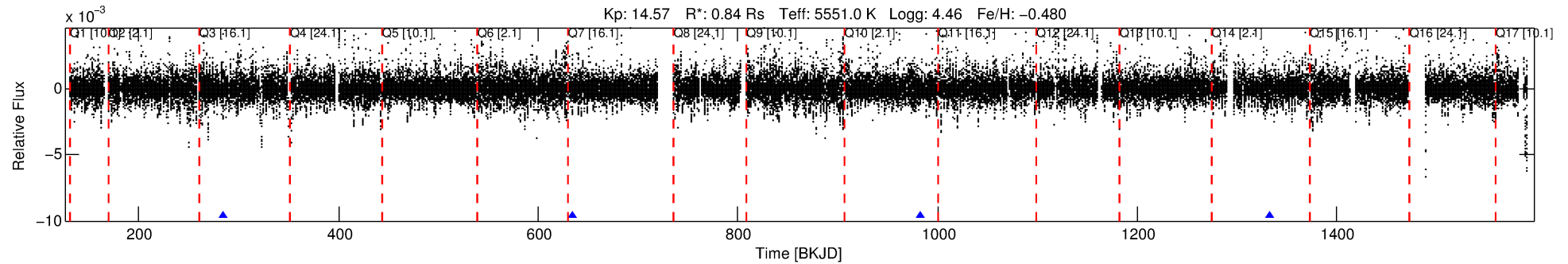
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 002987160-05

No Significant Match Found

# DV One-Page Summary

KIC: 2987160 Candidate: 5 of 5 Period: 349.223 d



## TPS TCE Results:

Period = 349.22316 d  
Epoch = 284.9909 BKJD

DV fit results are unavailable

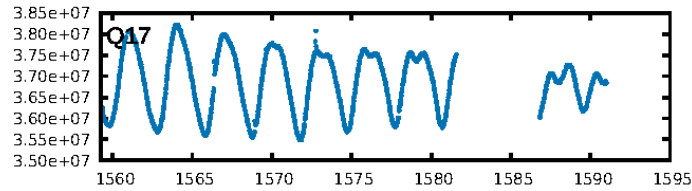
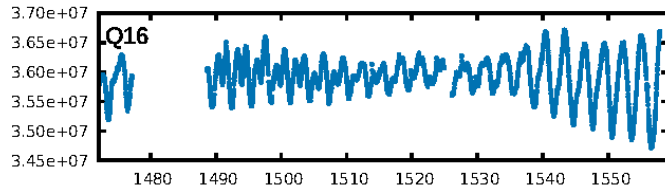
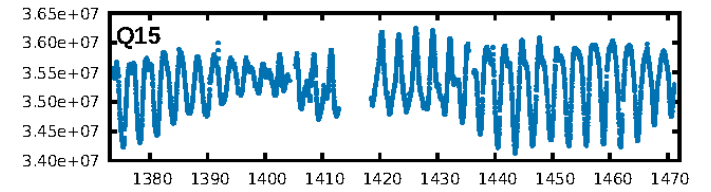
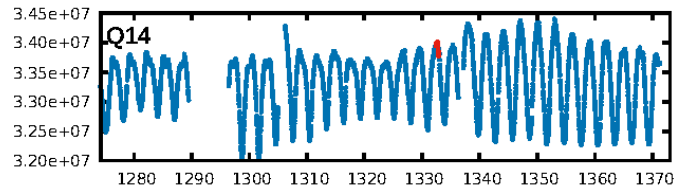
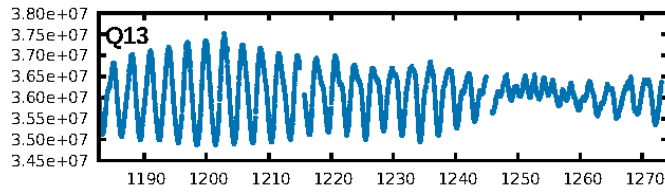
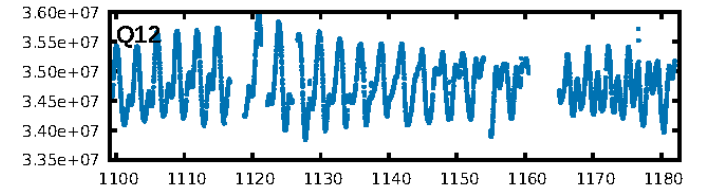
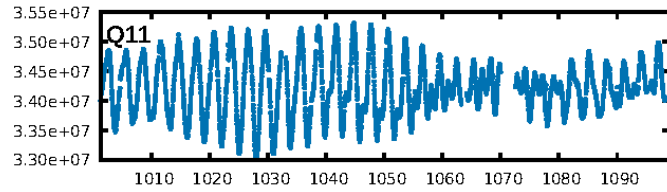
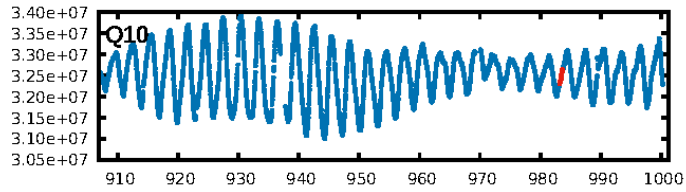
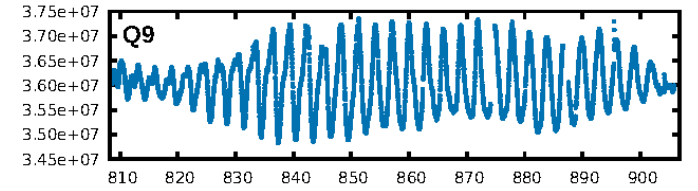
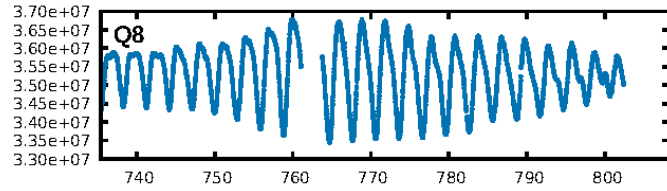
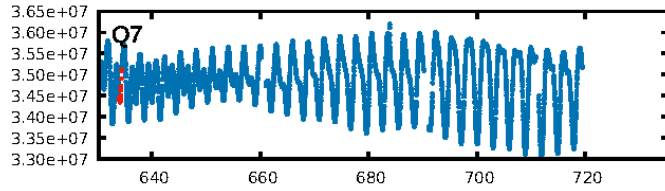
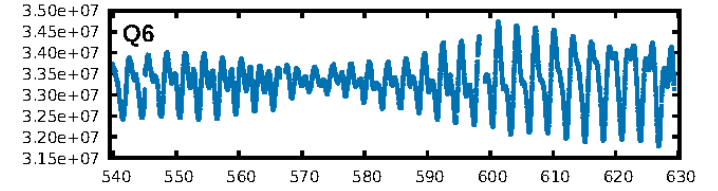
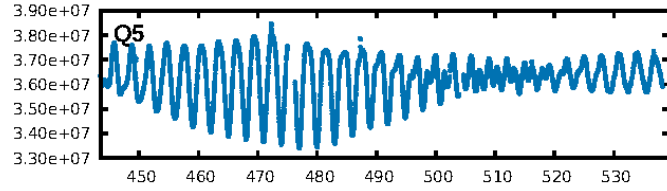
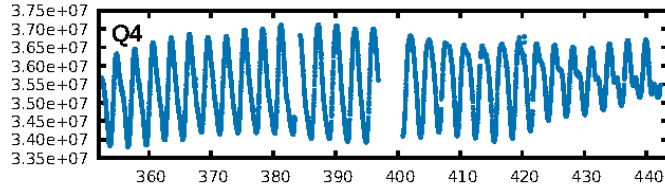
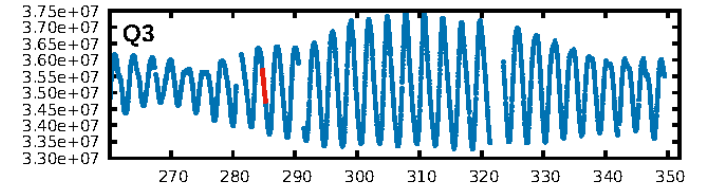
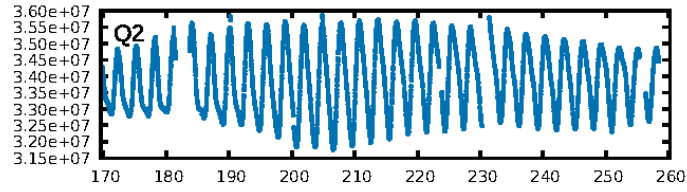
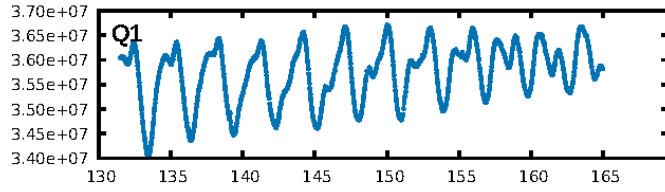
## DV Diagnostic Results:

ShortPeriod-sig: 100.0% [11.93 $\sigma$ ]  
LongPeriod-sig: 100.0% [71.89 $\sigma$ ]  
ModelChiSquare2-sig: N/A  
ModelChiSquareGof-sig: N/A  
Bootstrap-pfa: N/A  
RollingBand-fgt: 1.00 [3/3]  
GhostDiagnostic-chr: 0.4312  
Centroid-sig: 1.0%  
Centroid-so: 5.843 arcsec [2.02 $\sigma$ ]  
OotOffset-rm: 0.133 arcsec [0.46 $\sigma$ ]  
KicOffset-rm: 0.176 arcsec [0.58 $\sigma$ ]  
OotOffset-st: 2/1/0/0 [3]  
KicOffset-st: 2/1/0/0 [3]  
DiffImageQuality-fgm: 0.67 [2/3]  
DiffImageOverlap-fno: 0.67 [2/3]

Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 03-Feb-2016 07:58:05 Z

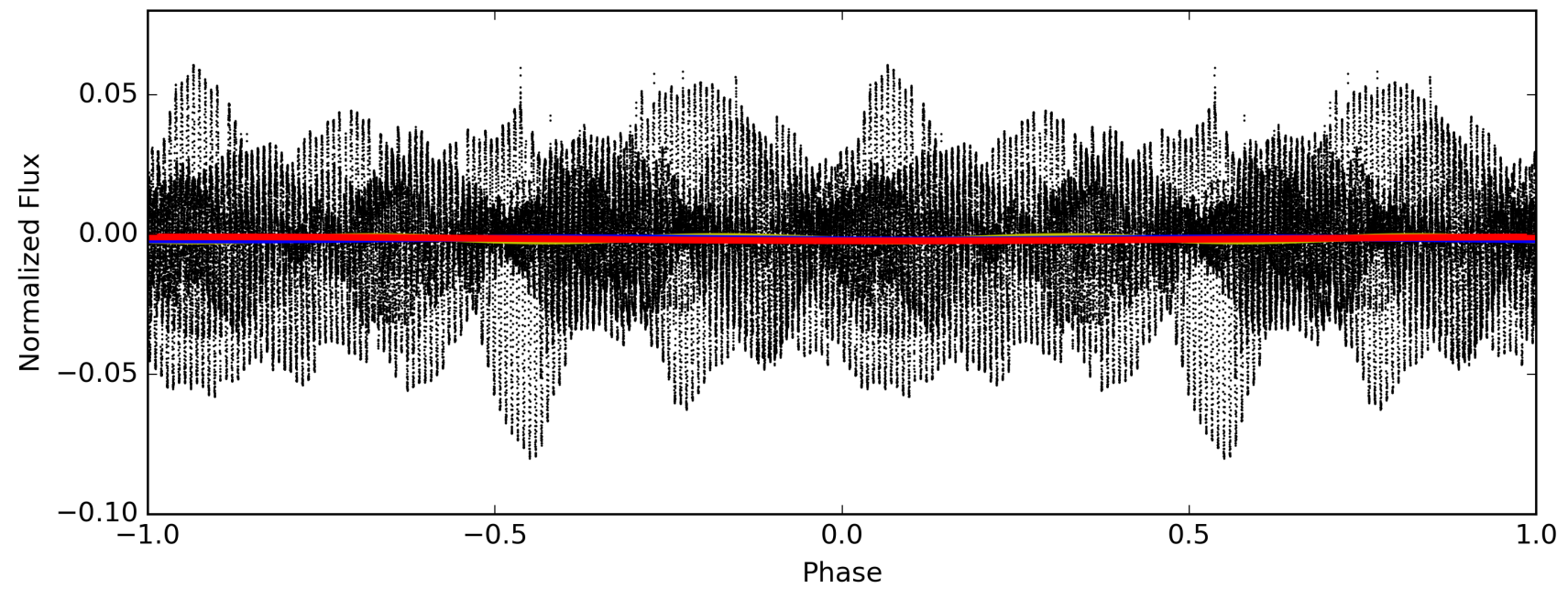
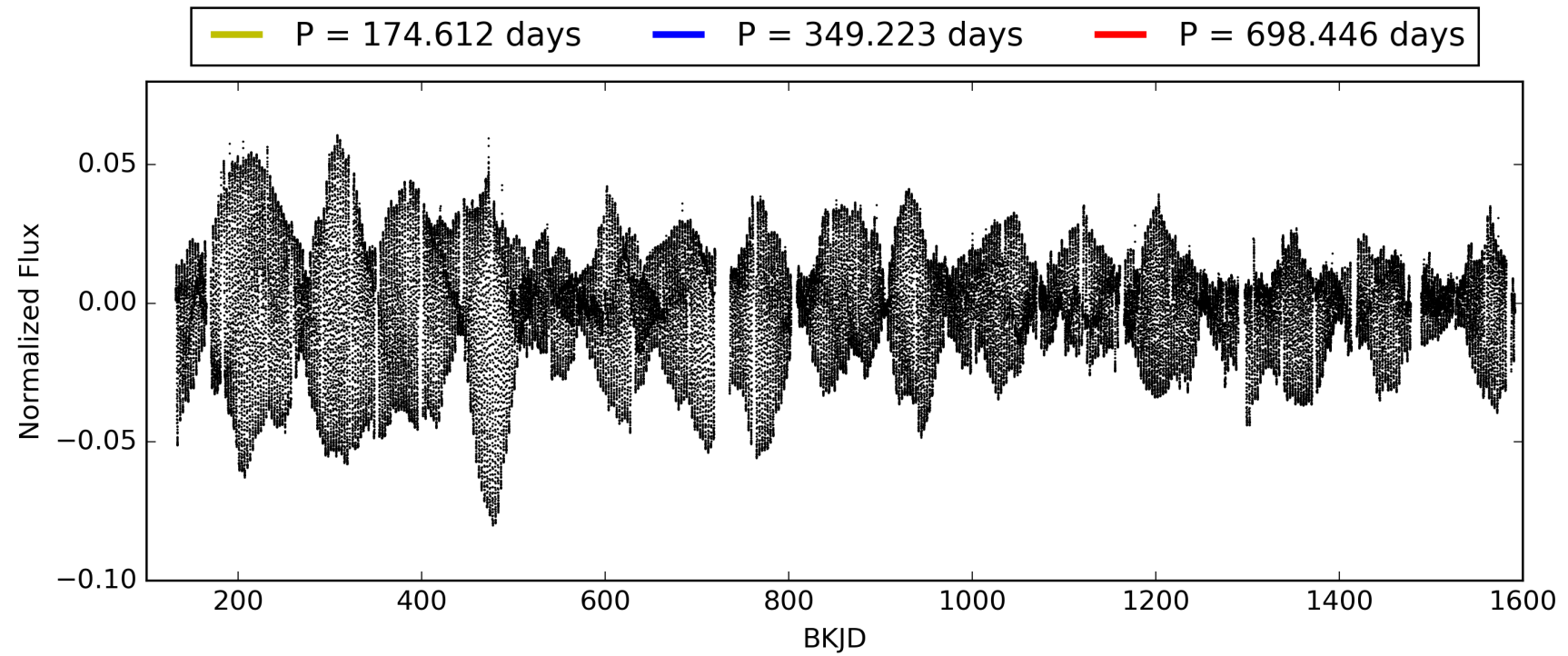
This Data Validation Report Summary was produced in the Kepler Science Operations Center Pipeline at NASA Ames Research Center

# TCE 002987160-05, PDC Light Curves





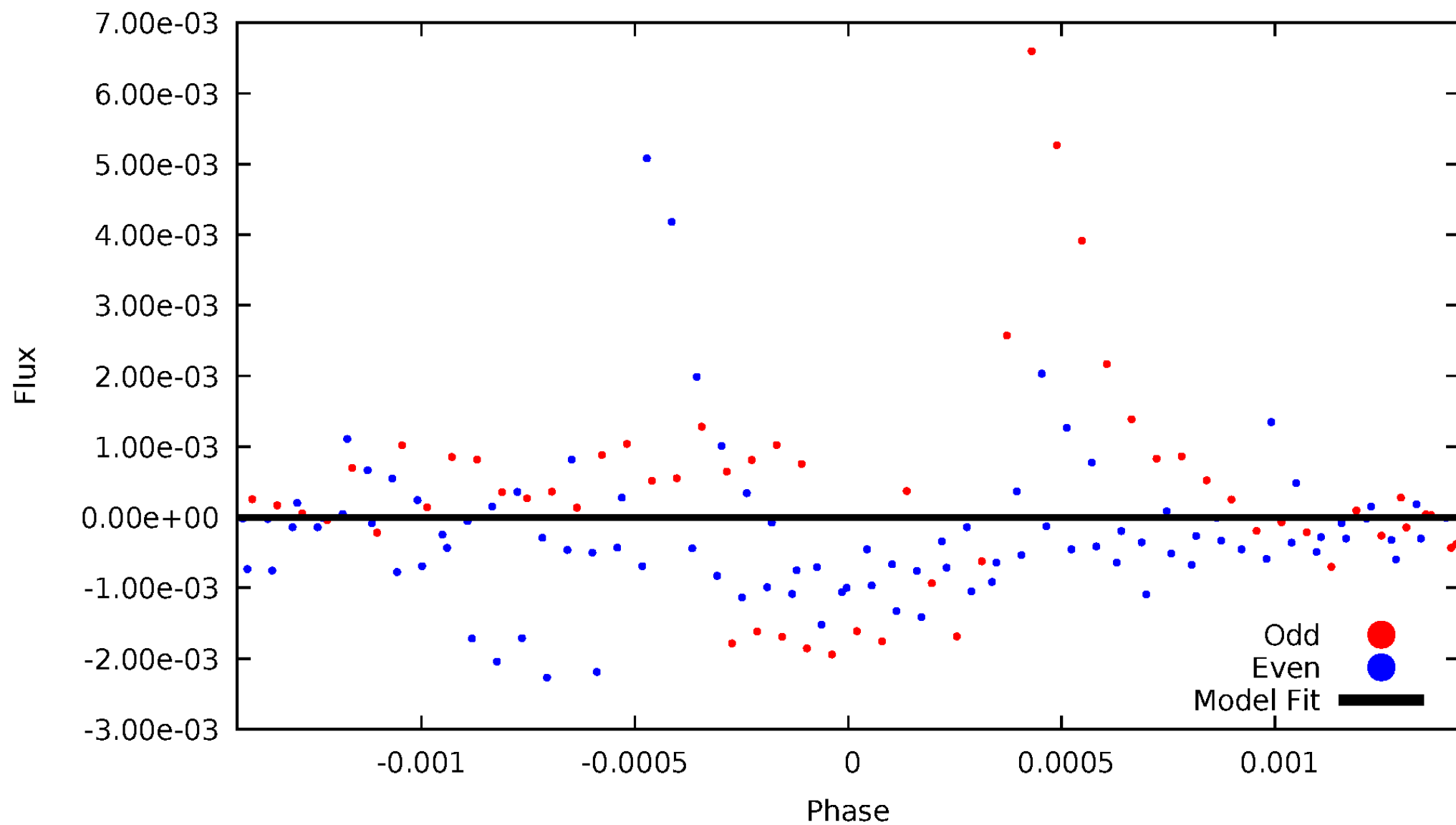
TCE 002987160-05





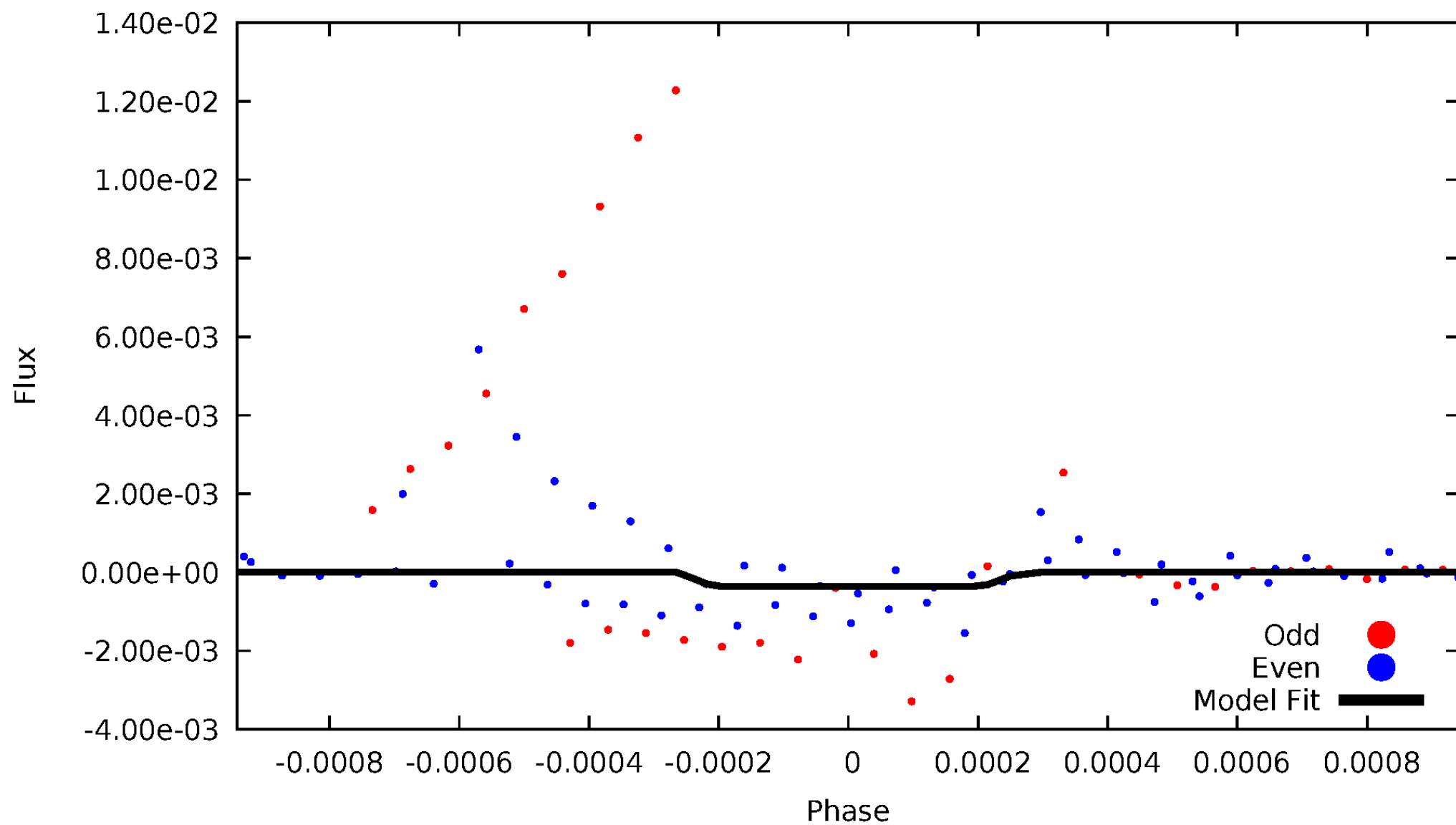
# DV Odd/Even

TCE 002987160-05



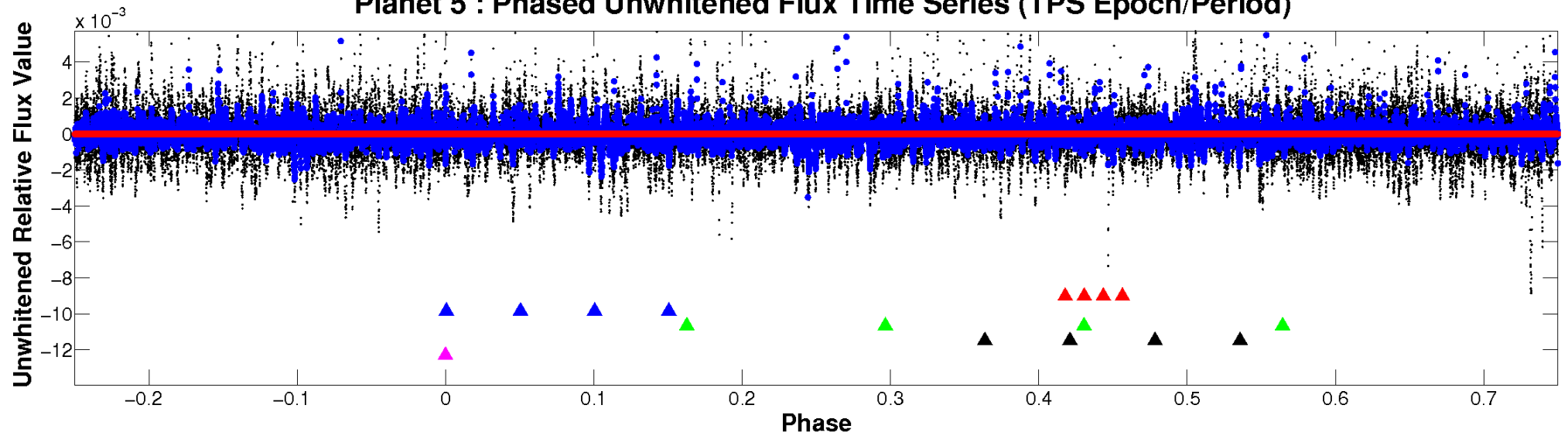
# ALT Odd/Even

TCE 002987160-05



# Non-Whitened Vs. Whitened Light Curve

**Planet 5 : Phased Unwhitened Flux Time Series (TPS Epoch/Period)**

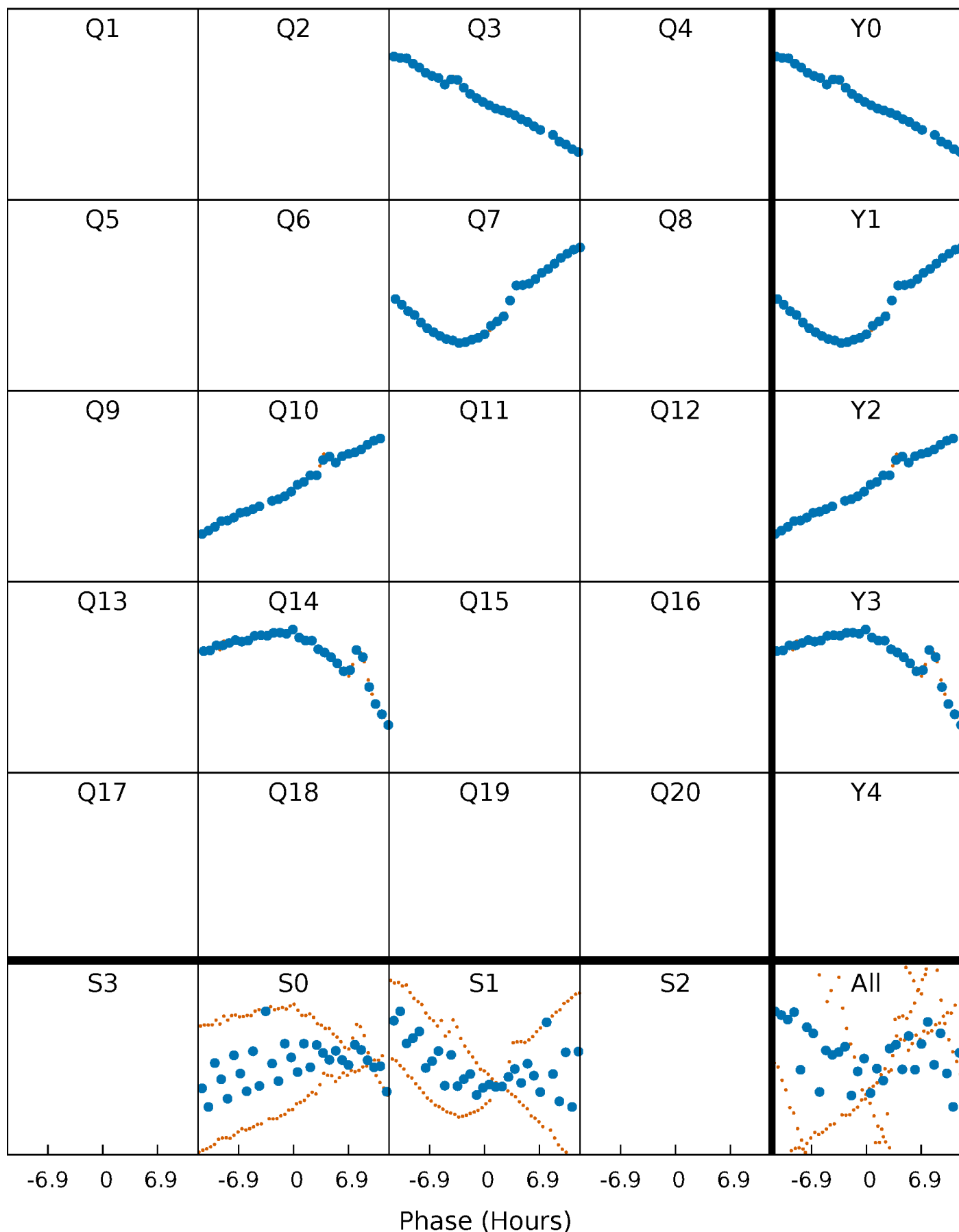


**Planet 5 : Phased Whitened Flux Time Series (TPS Epoch/Period)**



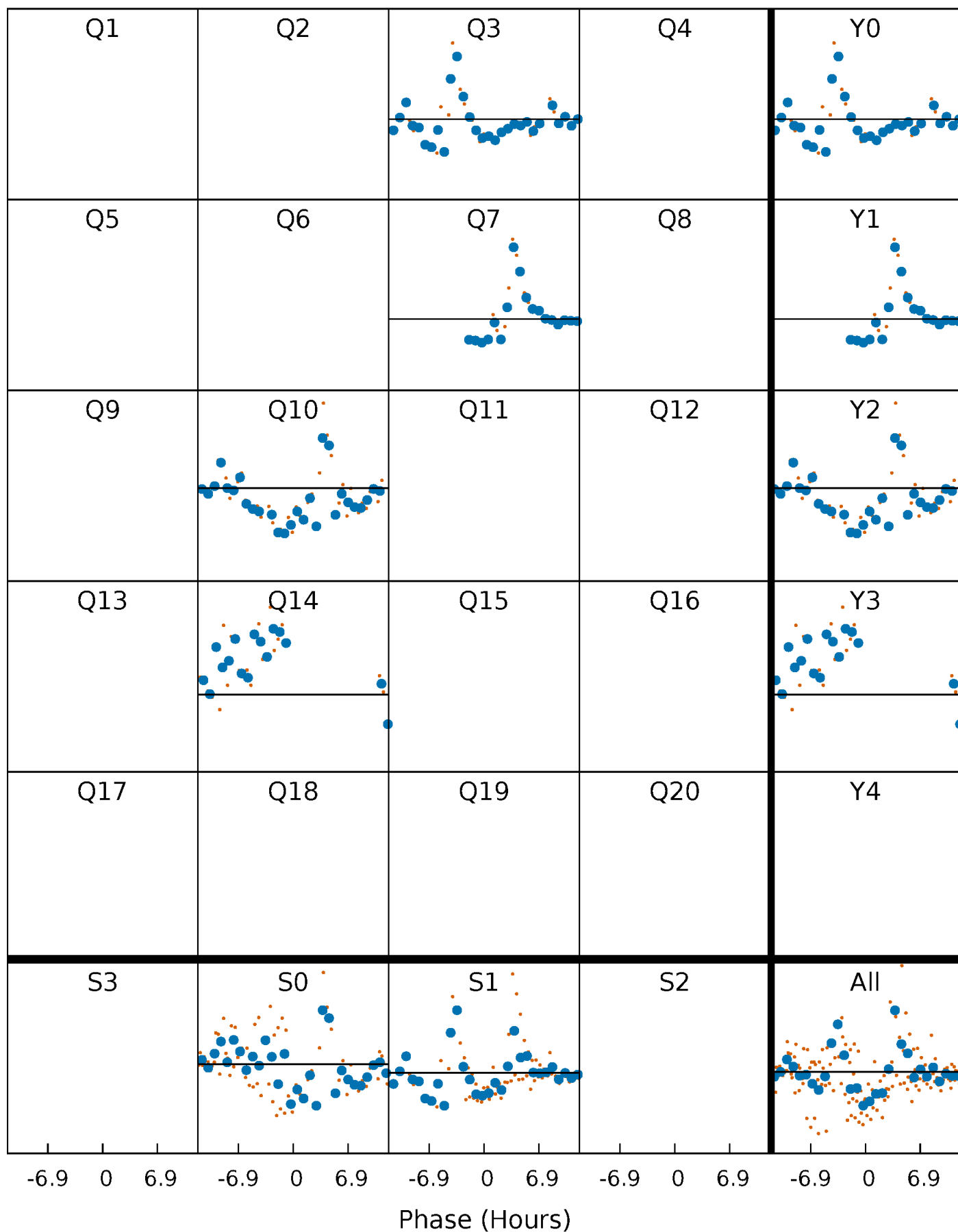
# PDC Quarter-Phased Transit Curves

TCE 002987160-05     $P=349.223163$  Days     $T_0=284.990869$  (BKJD)



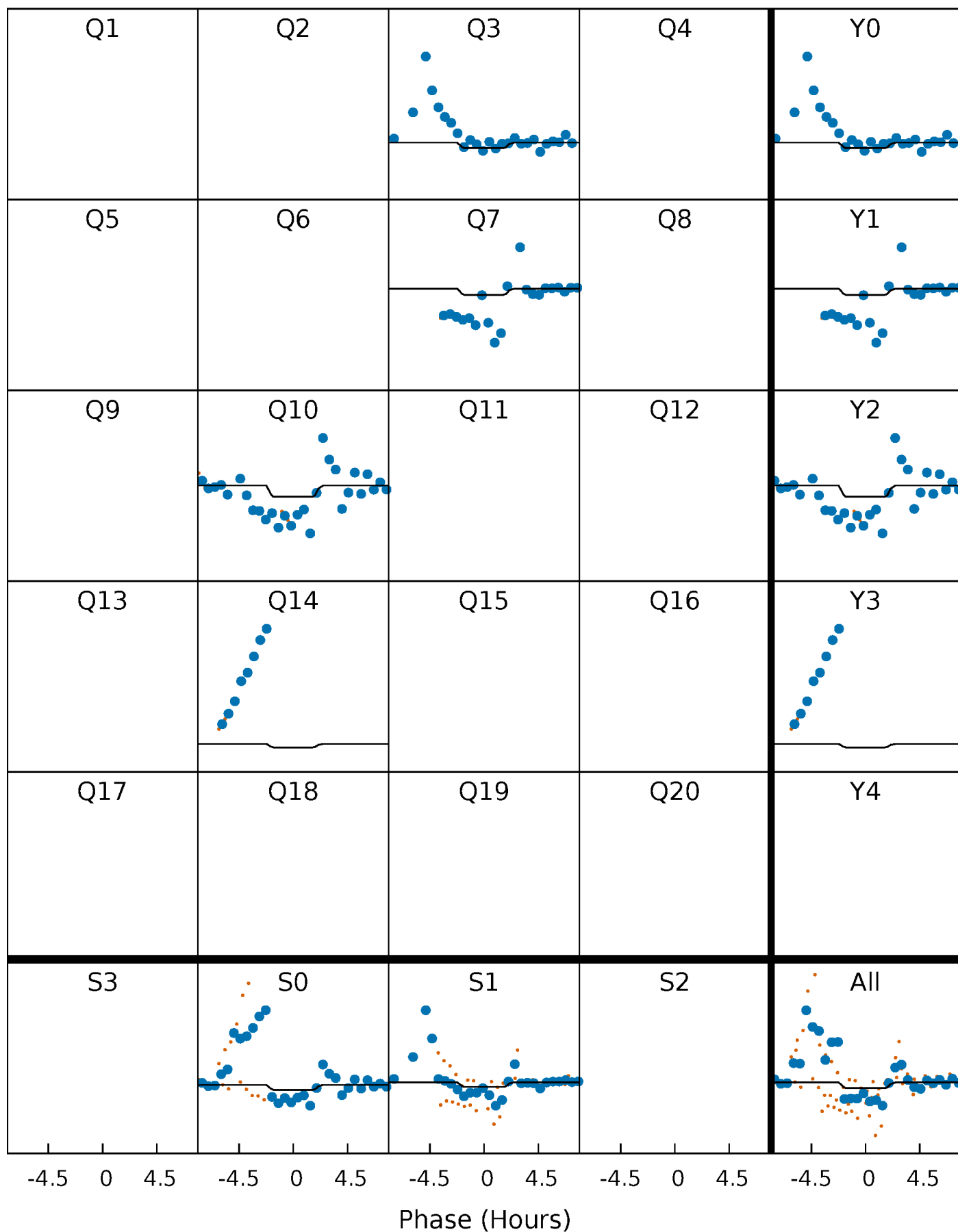
# DV Quarter-Phased Transit Curves

TCE 002987160-05     $P=349.223163$  Days     $T_0=284.990869$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

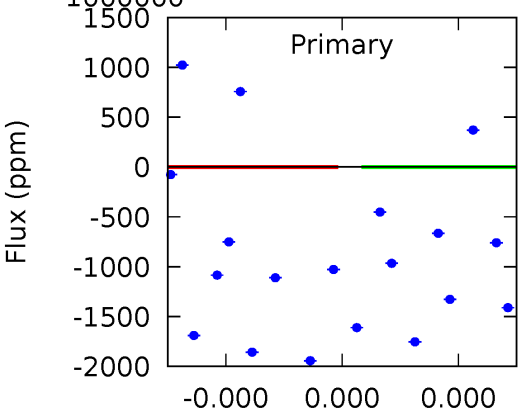
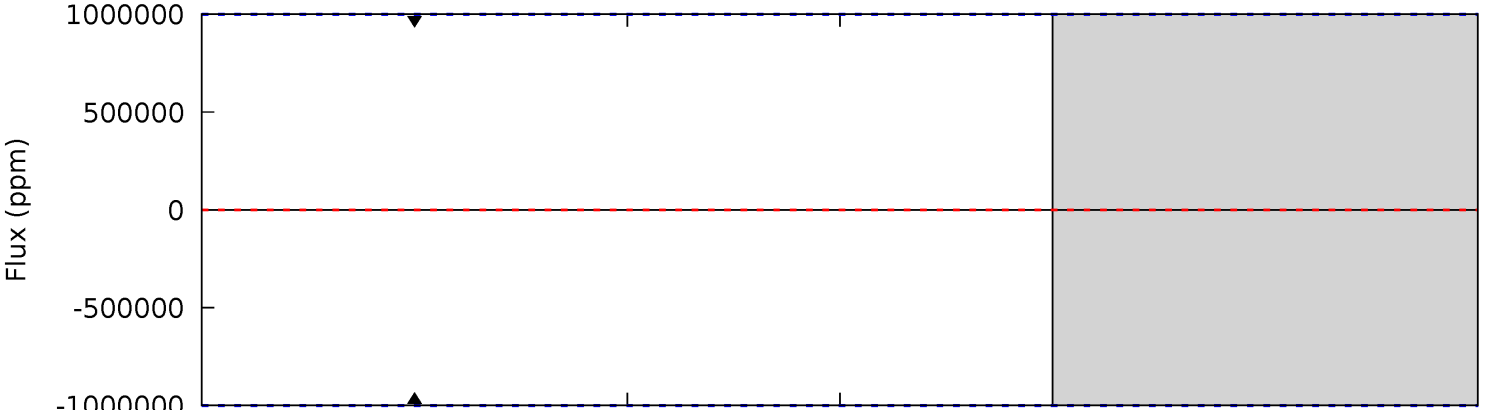
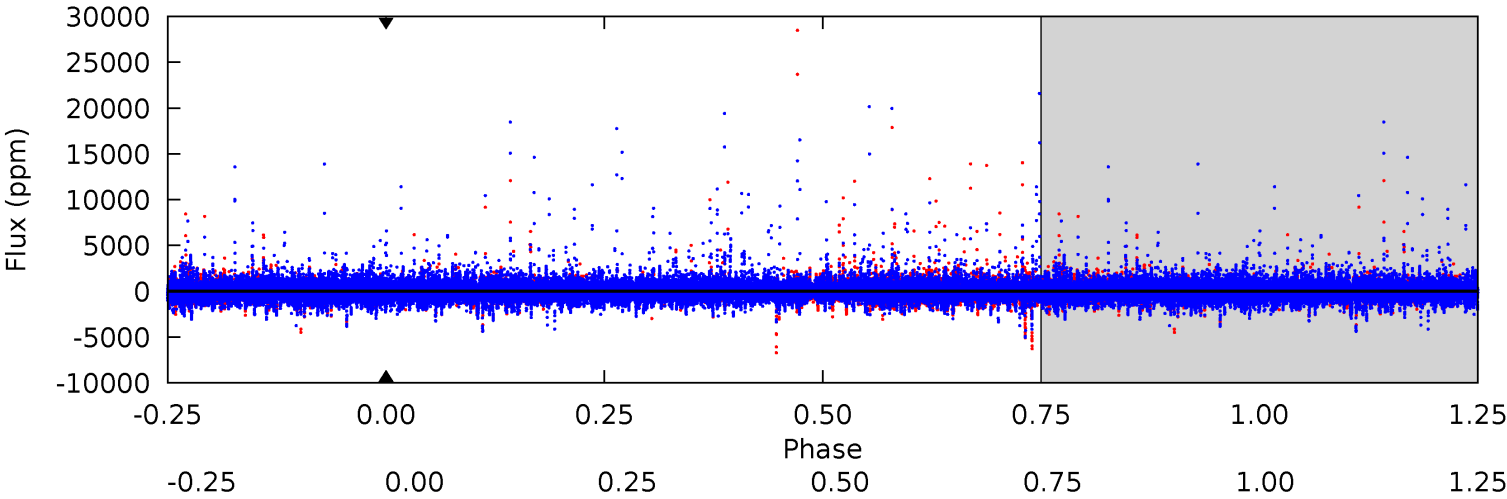
TCE 002987160-05     $P=349.223163$  Days     $T_0=285.045543$  (BKJD)



# DV Model-Shift Uniqueness Test

002987160-05, P = 349.223163 Days, E = 284.990869 Days

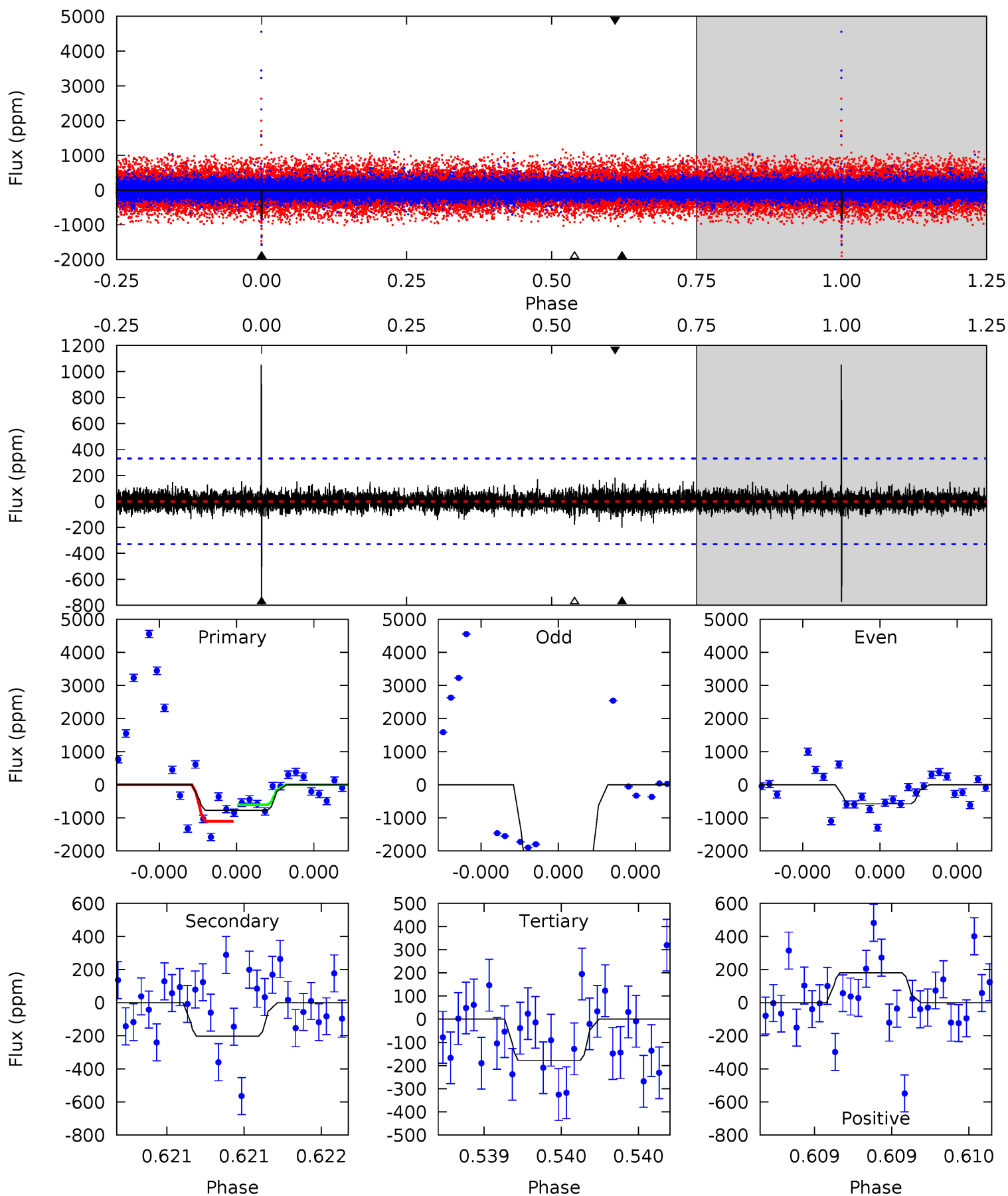
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
0	0	0	0	1.00	1.00	1.00	0	0	0	0	0	0	0	0



# Alt Model-Shift Uniqueness Test

002987160-05, P = 349.223163 Days, E = 285.045543 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
13.1	3.43	3.01	3.06	5.58	3.49	0.65	10.1	10.0	0.43	0.38	14.4	0.94	0.58	4.09





### Stellar Parameters For KIC 002987160

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R$ ( $R_{\odot}$ )	$M(M_{\odot})$	$p_{\star}$ ( $\text{g}\cdot\text{cm}^{-3}$ )
	$5551^{+166}_{-166}$	$4.455^{+0.139}_{-0.186}$	$-0.480^{+0.300}_{-0.300}$	$0.844^{+0.182}_{-0.121}$	$0.742^{+0.118}_{-0.047}$	$1.738^{+1.037}_{-0.750}$
	+3%/-3%	+3%/-4%	+62%/-62%	+22%/-14%	+16%/-6%	+60%/-43%
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 002987160-05 / KOI

Detrend	Depth (ppm)	$R_p$ ( $R_{\oplus}$ )	$T_{max}$ (K)	$T_{obs}$ (K)	$A_{obs}$
DV	$0 \pm 1000000$	$7.52^{+7.90}_{-4.72}$	$338^{+23}_{-18}$	$2844^{+13723}_{-19615}$	$1476^{+1190087}_{-1150421}$
Alt.	$-203 \pm 59$	$7.46^{+6.99}_{-5.16}$	$338^{+22}_{-20}$	$3018^{+1319}_{-489}$	$1576^{+13111}_{-1169}$

$T_{max}$  = 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

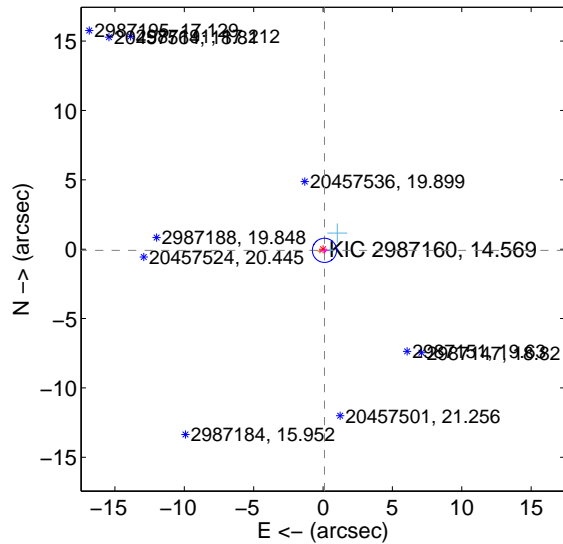
Supplemental centroid analysis for 002987160-05. Kepler magnitude: 14.57. Transit SNR -1.00

There are 2 quarters with good PRF difference image offsets

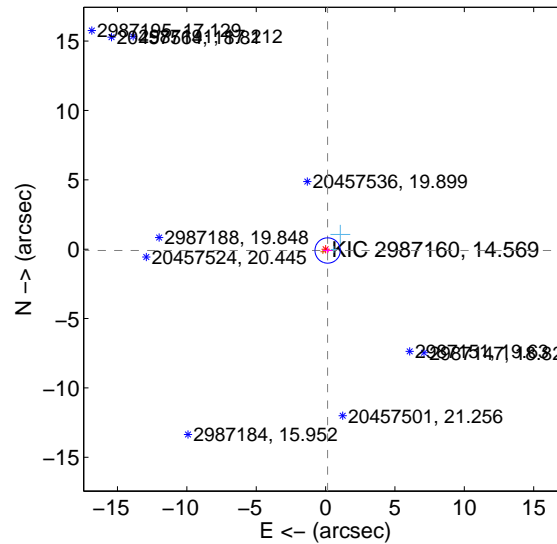
The direct PRF centroid is offset from the target star catalog position by about 0.06 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.133 \pm 0.290$	0.46	$-0.103 \pm 0.325$	$-0.084 \pm 0.230$
PRF-fit source offset from KIC position	$0.176 \pm 0.304$	0.58	$-0.148 \pm 0.338$	$-0.095 \pm 0.201$
photometric centroid source offset	$5.84 \pm 2.90$	2.02	$-3.93 \pm 2.49$	$-4.33 \pm 3.19$

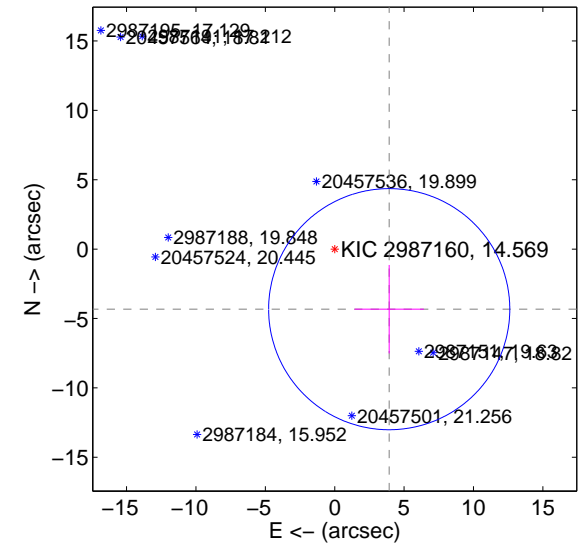
offset from difference PRF-fit to OOT PRF-fit



offset from difference PRF-fit to KIC position

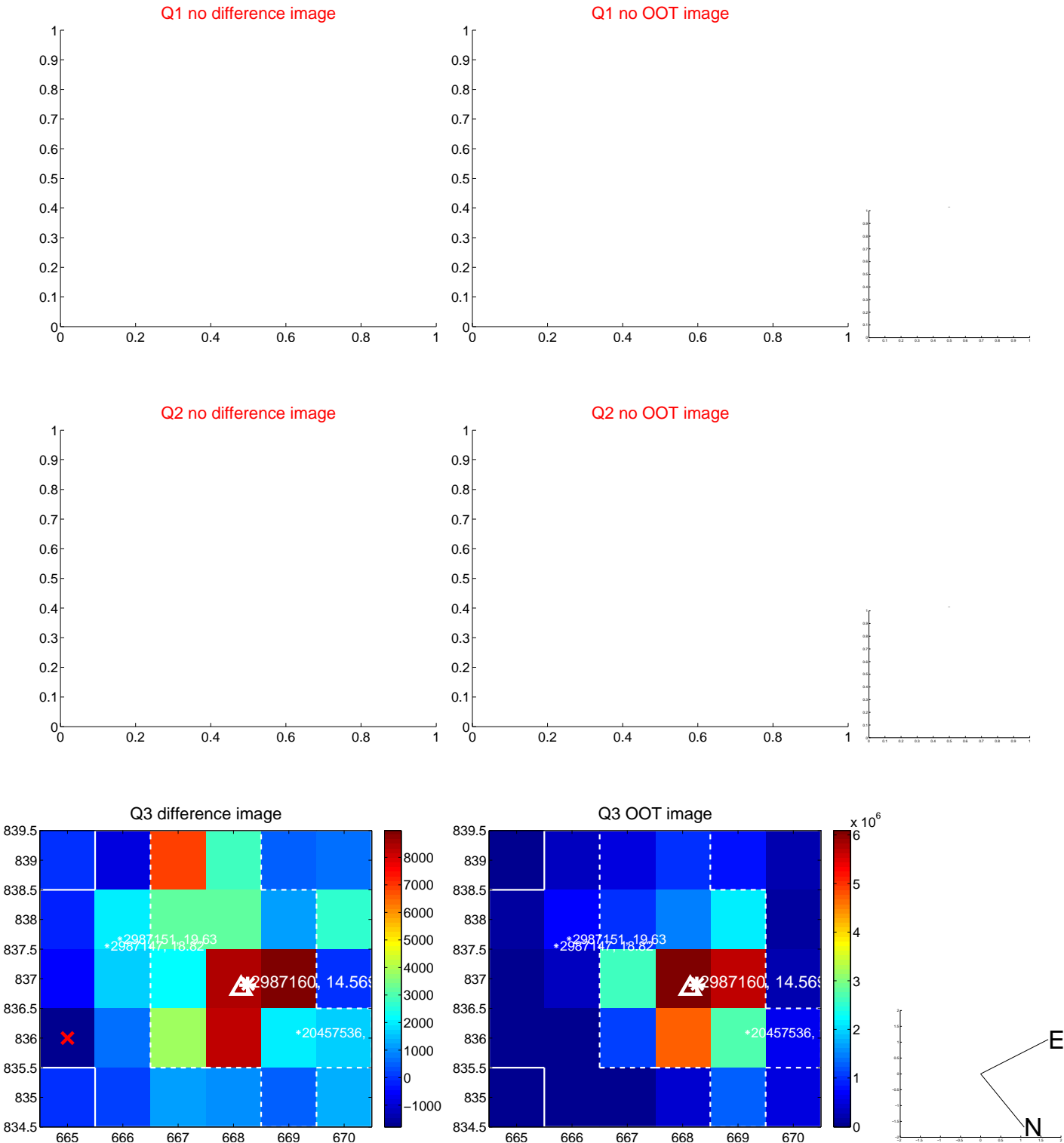


offset from photometric centroids



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.

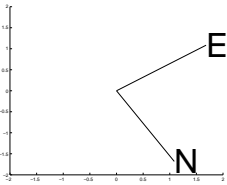
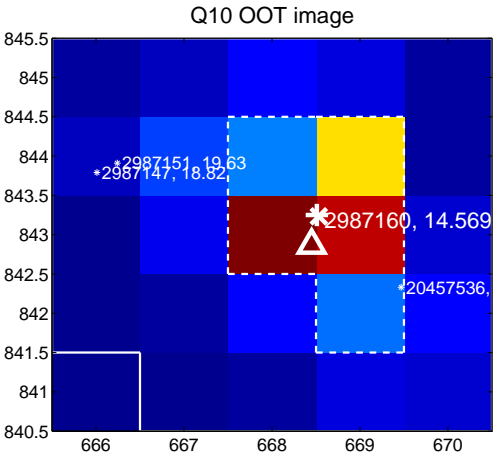
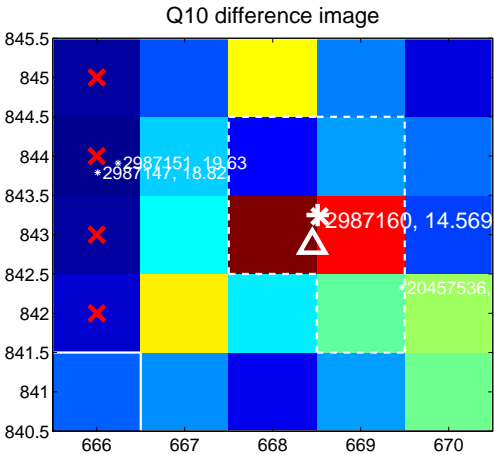


white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

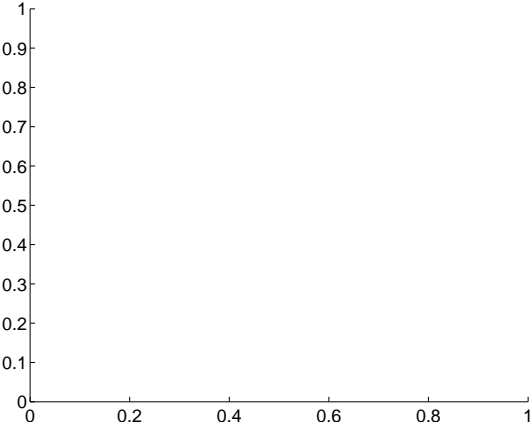
Q9 no difference image



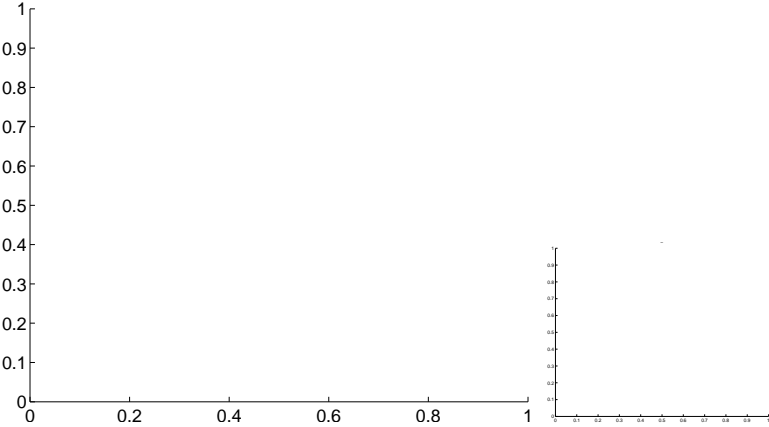
Q9 no OOT image



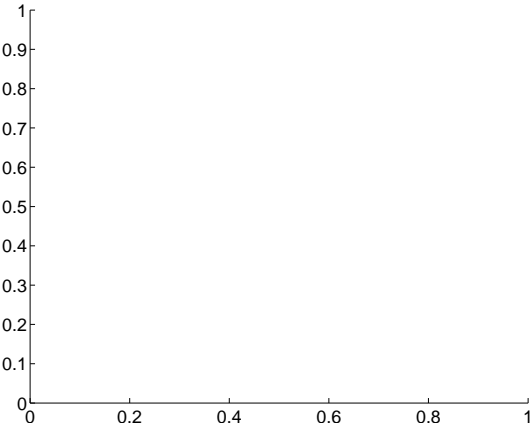
Q11 no difference image



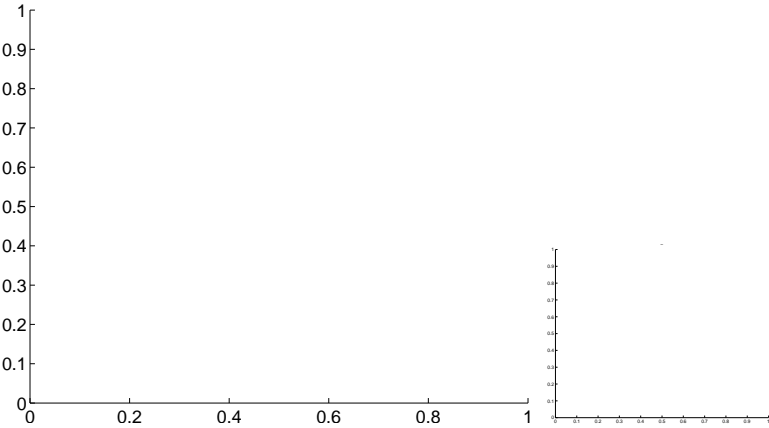
Q11 no OOT image



Q12 no difference image



Q12 no OOT image



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

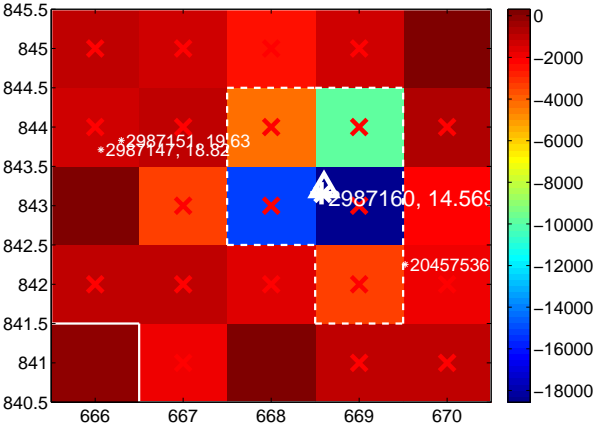
Q13 no difference image



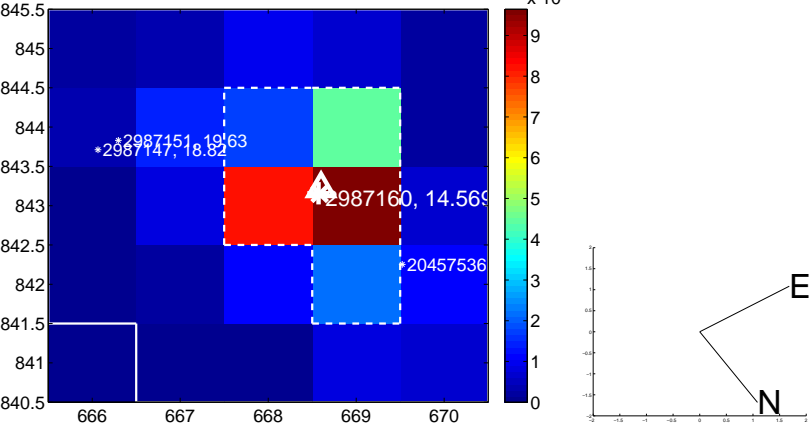
Q13 no OOT image



Q14 difference image. Poor Quality



Q14 OOT image



Q15 no difference image



Q15 no OOT image



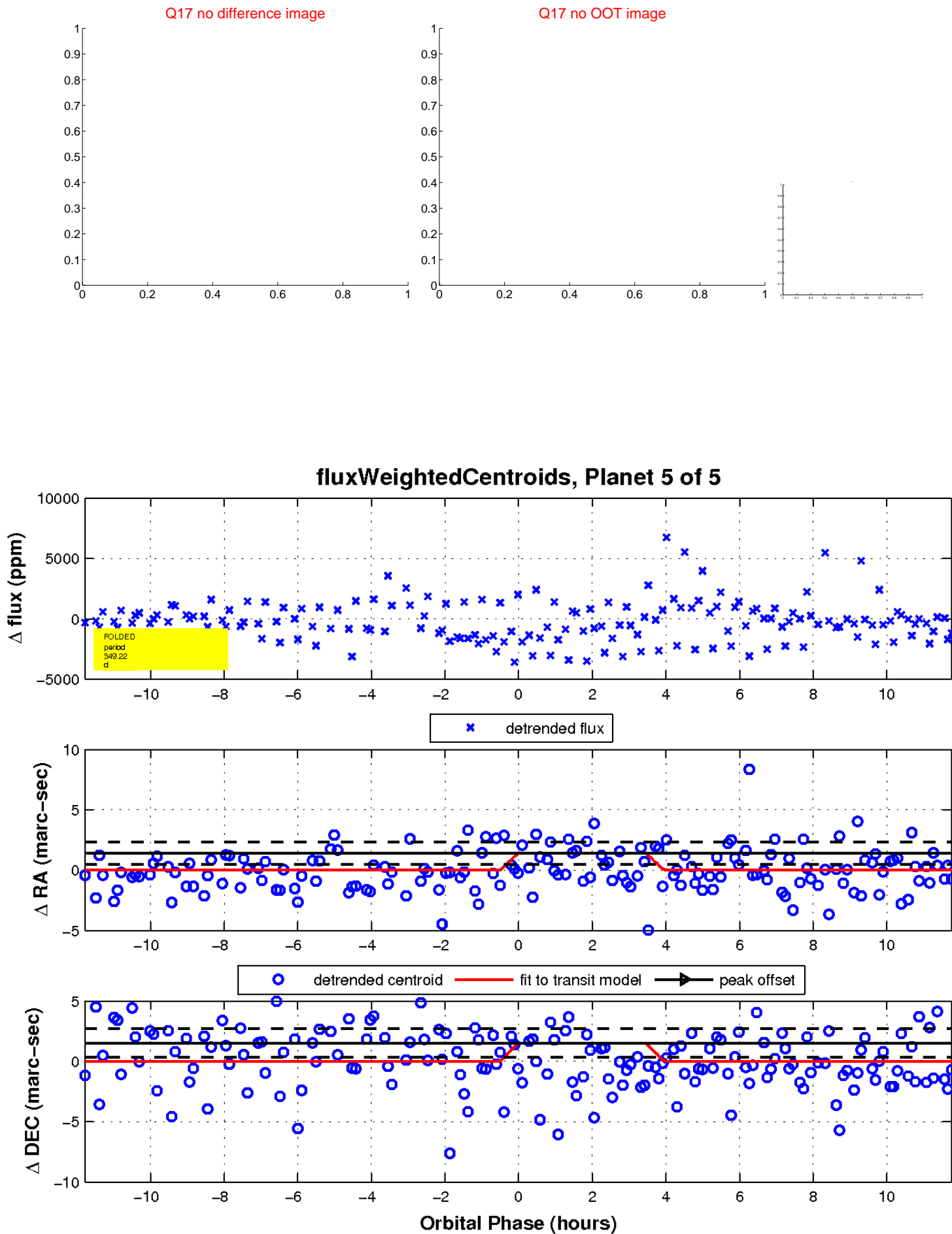
Q16 no difference image



Q16 no OOT image



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



UKIRT Image

Declination

