

# KIC 009730163

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
009730163-01	OBS	2704.01	4.871228	133.642062	6310.4	1.574	42.0	47.7	0.18	3157	1.52	3.19
009730163-02	OBS	2704.02	2.984148	133.121842	2367.6	1.240	19.5	21.7	0.18	3157	0.89	6.12

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
009730163-01	OBS	PC	1.00	0	0	0	0	CENT_KIC_POS
009730163-02	OBS	PC	0.94	0	0	0	0	CENT_KIC_POS

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

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

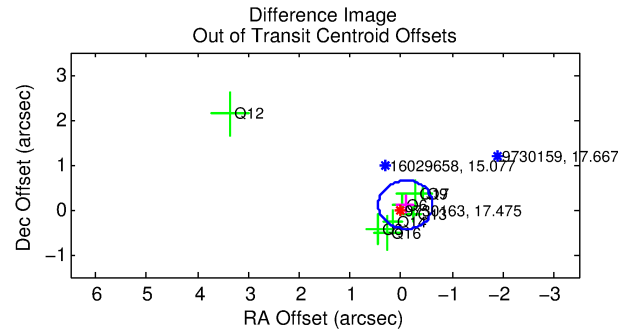
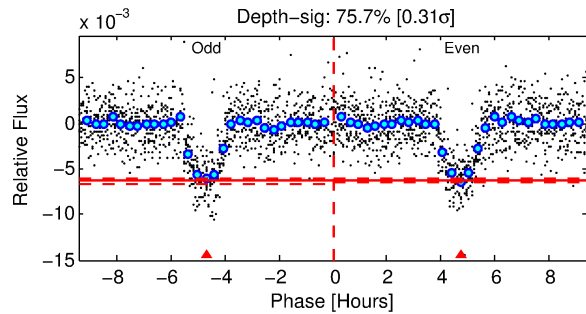
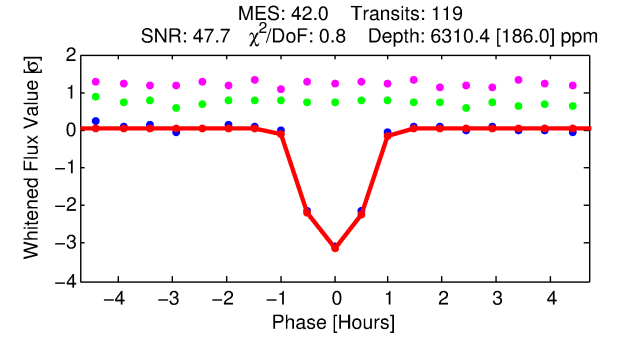
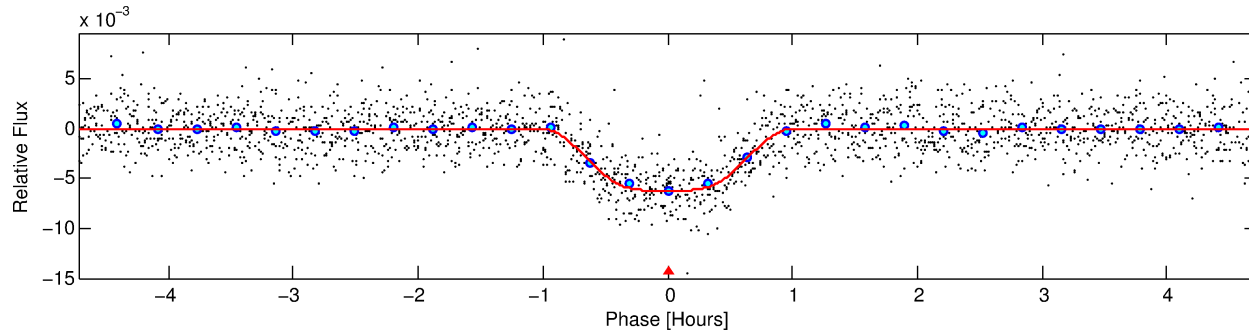
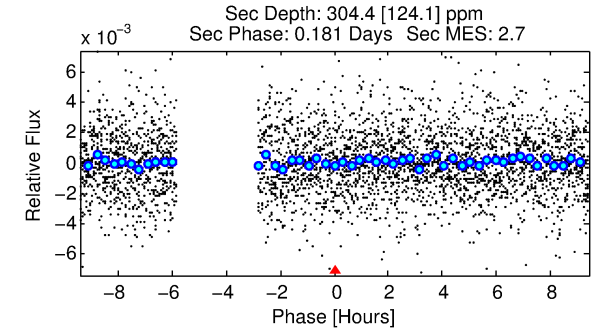
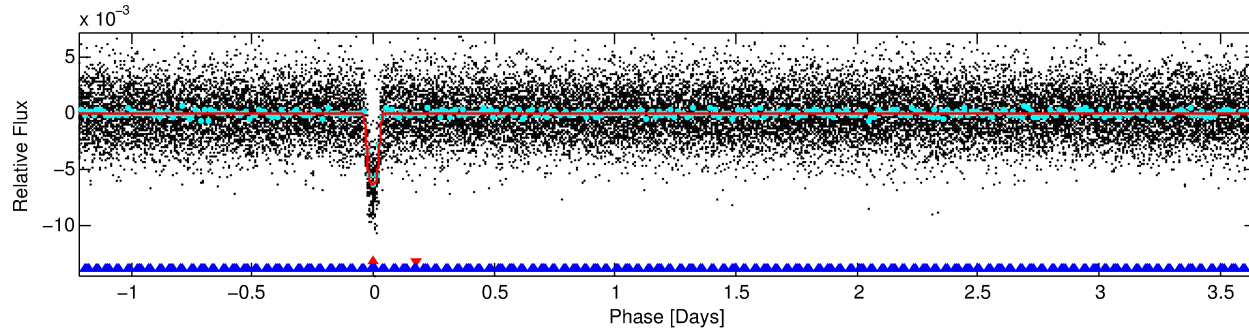
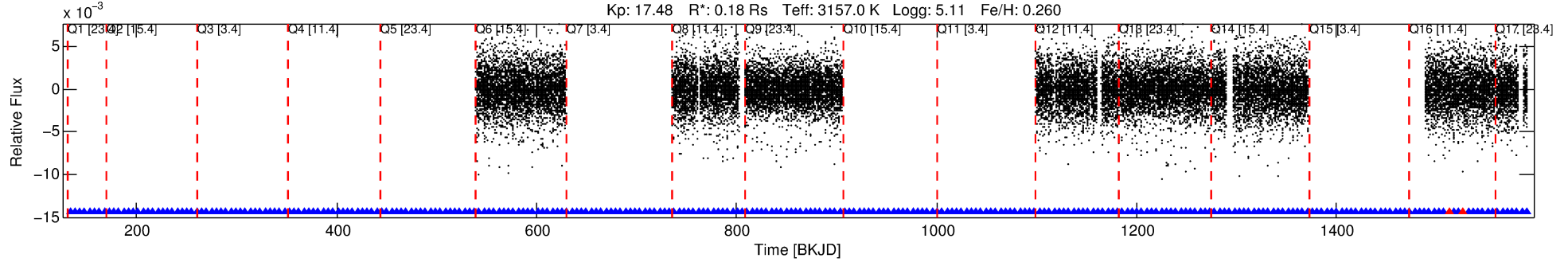
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 009730163-01

No Significant Match Found

# DV One-Page Summary

KIC: 9730163 Candidate: 1 of 2 Period: 4.871 d  
KOI: K02704.01 Name: Kepler-445c Corr: 0.984



## DV Fit Results:

Period = 4.87123 [0.00001] d  
Epoch = 133.6421 [0.0008] BKJD  
Rp/R\* = 0.0776 [0.0112]  
a/R\* = 19.67 [10.88]  
b = 0.69 [0.43]  
Seff = 3.19 [1.17]  
Teq = 341 [31] K  
Rp = 1.52 [0.72] Re  
a = 0.0301 [0.0095] AU  
Ag = 65.17 [39.95] [1.61σ]  
Teffp = 1497 [190] K [5.99σ]

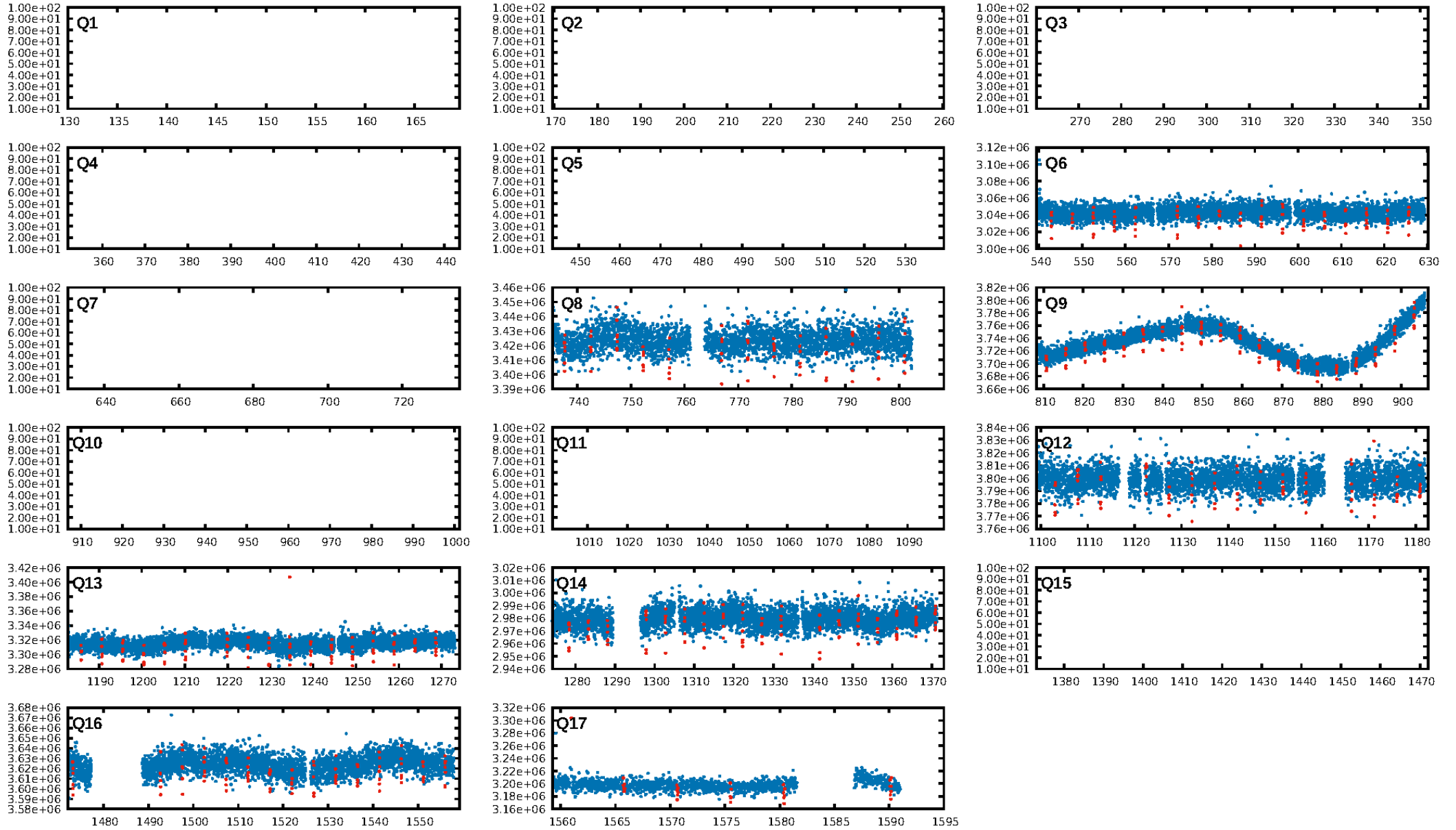
## DV Diagnostic Results:

ShortPeriod-sig: 100.0% [22.60σ]  
LongPeriod-sig: N/A  
ModelChiSquare2-sig: 73.7%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 0.00e+00  
RollingBand-fgt: 0.98 [112/114]  
GhostDiagnostic-chr: 2.025  
Centroid-sig: 77.0%  
Centroid-so: 1.106 arcsec [4.03σ]  
OotOffset-rm: 0.140 arcsec [0.78σ]  
KicOffset-rm: 1.313 arcsec [3.52σ]  
OotOffset-st: 2/0/3/3 [8]  
KicOffset-st: 2/0/3/3 [8]  
DiffImageQuality-fgm: 0.88 [7/8]  
DiffImageOverlap-fno: 1.00 [8/8]

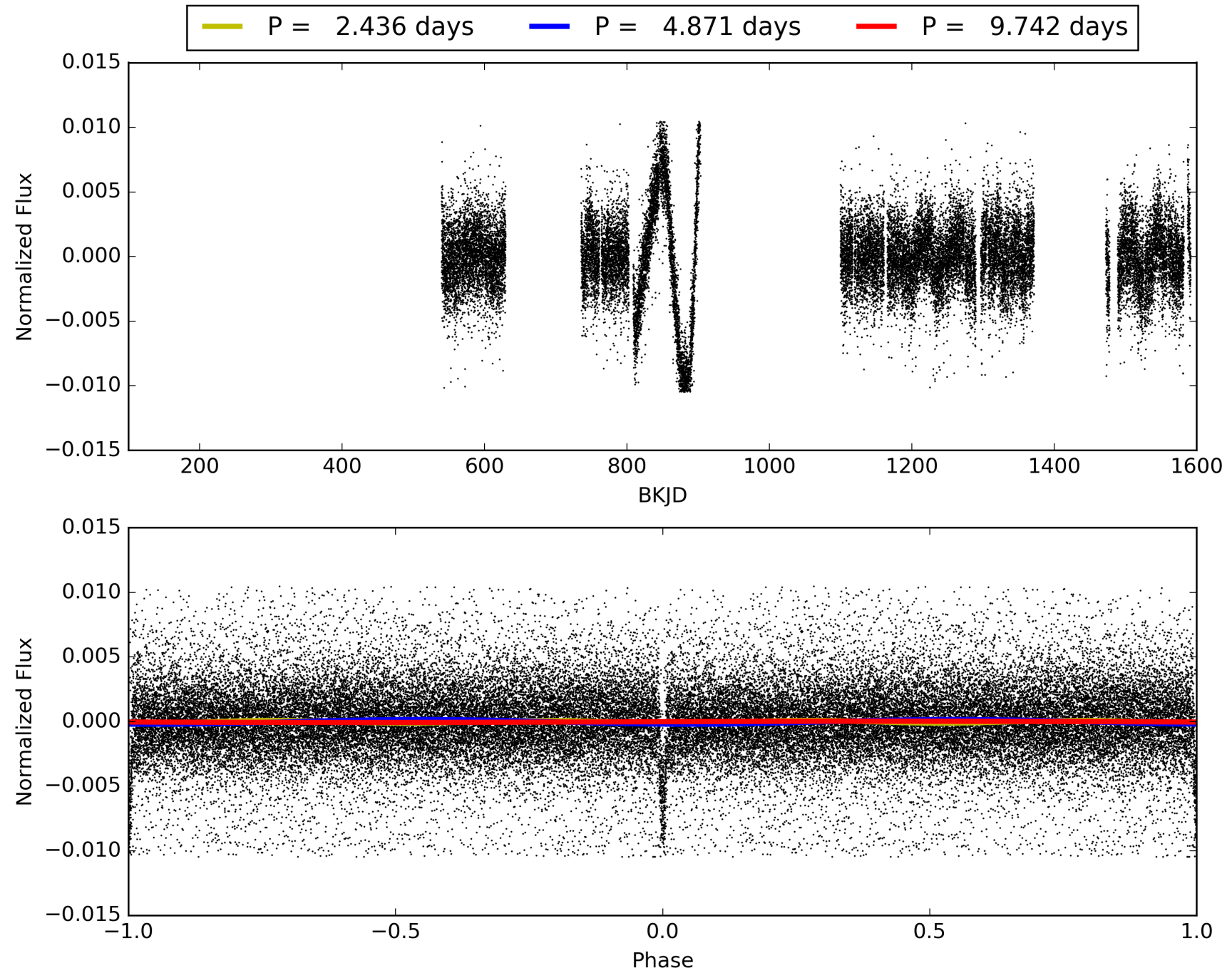
Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 31-Jan-2016 15:01:50 Z

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

# TCE 009730163-01, PDC Light Curves

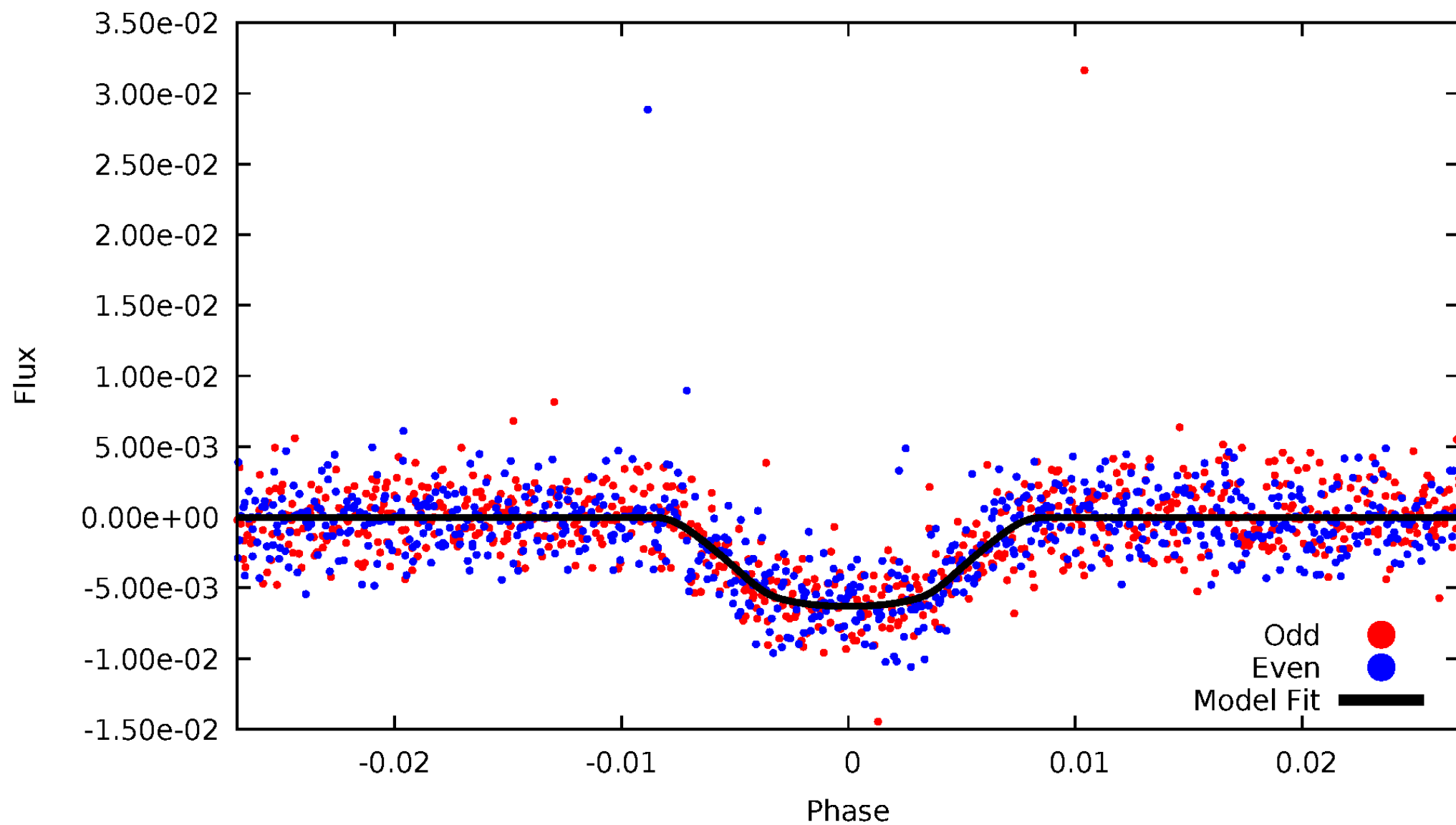


TCE 009730163-01



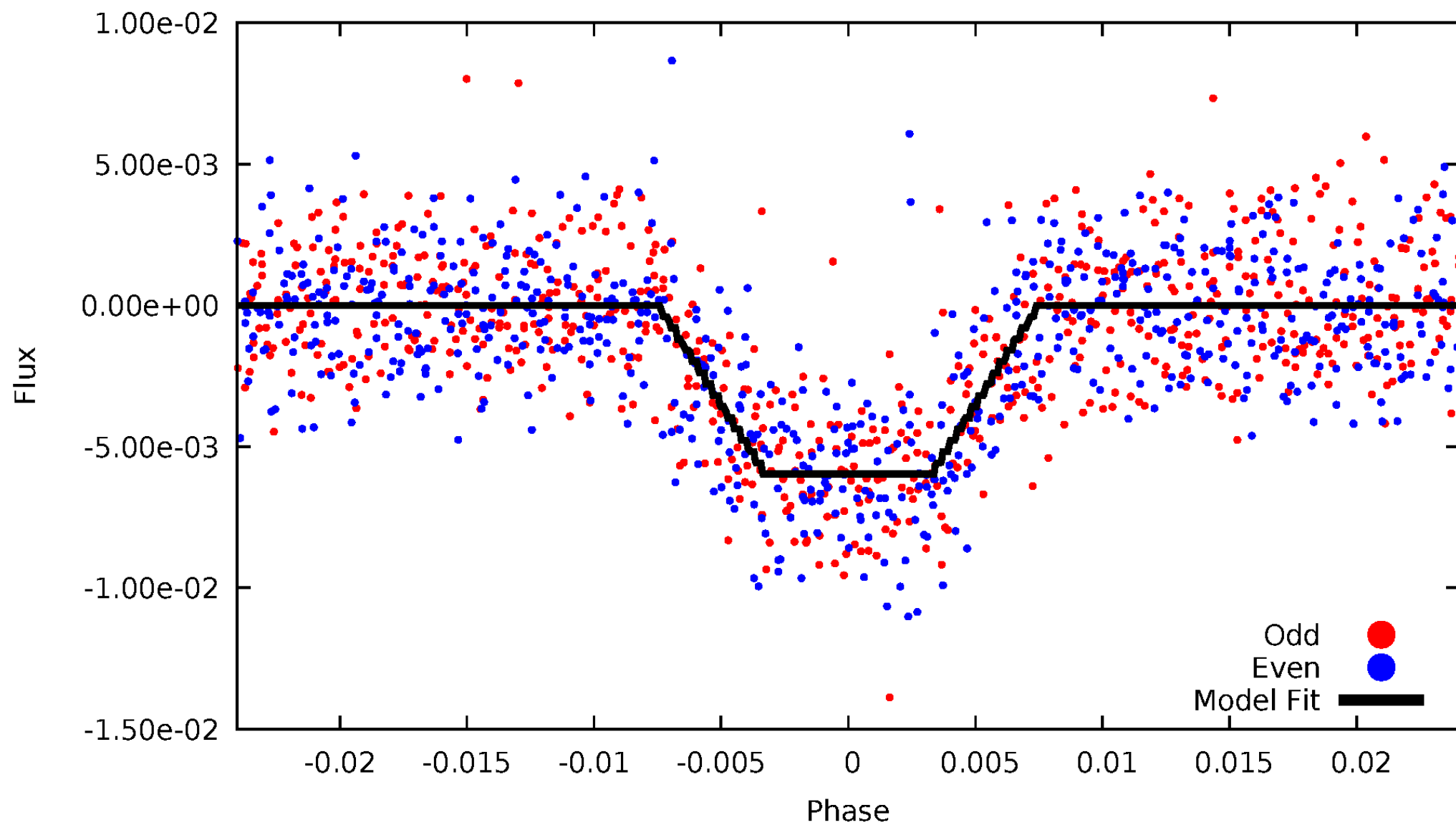
# DV Odd/Even

TCE 009730163-01

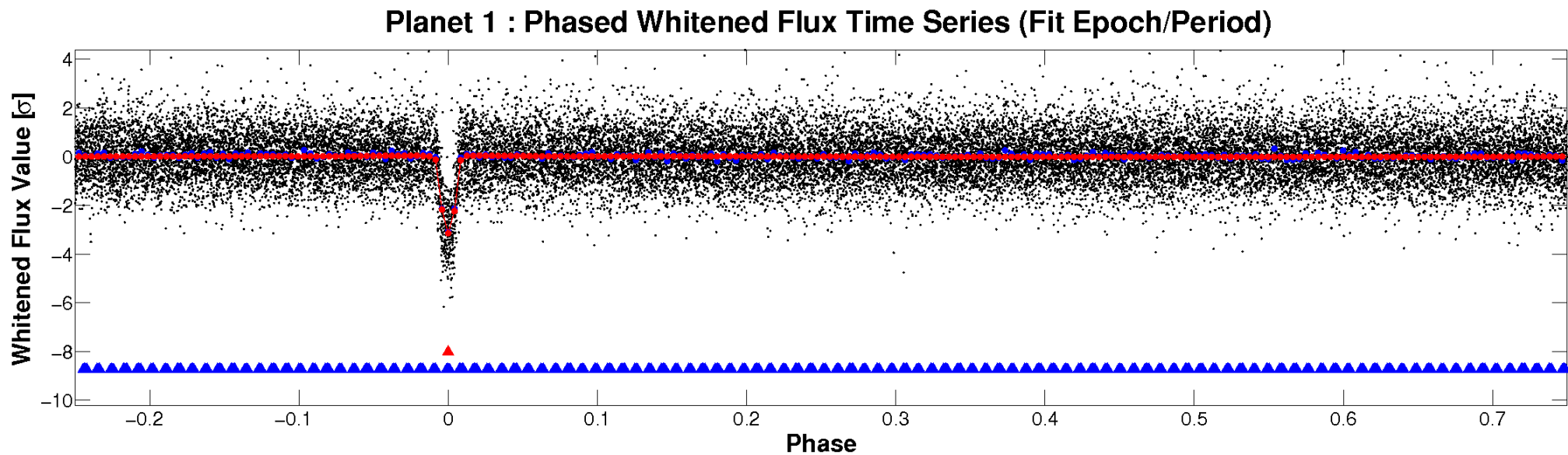
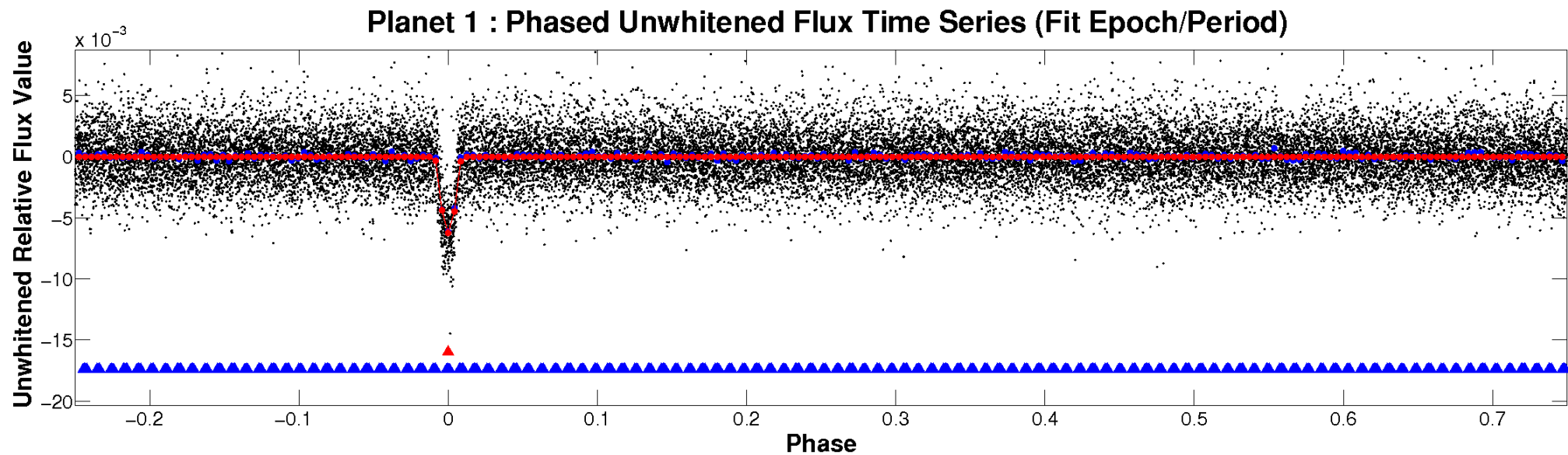


# ALT Odd/Even

TCE 009730163-01



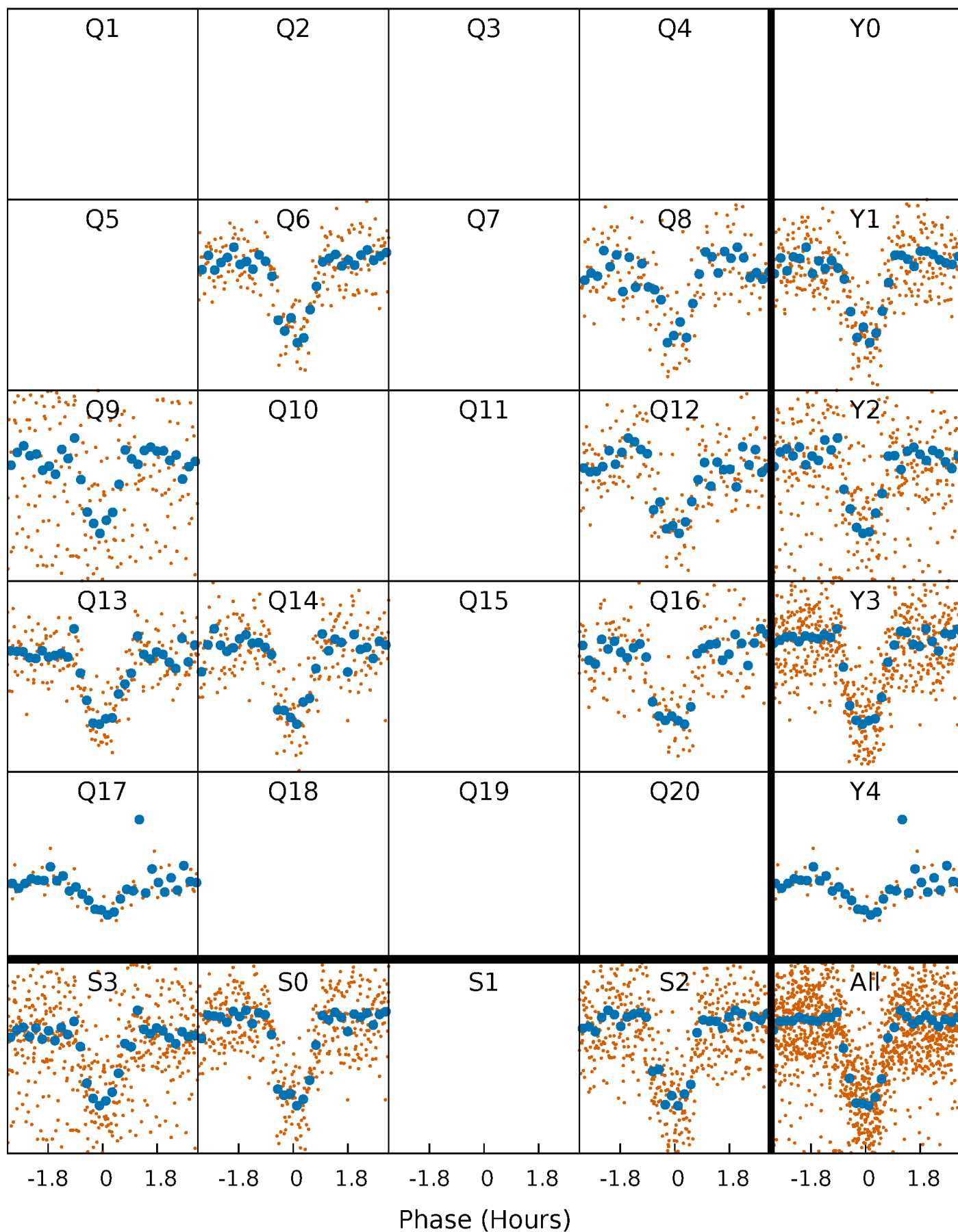
# Non-Whitened Vs. Whitened Light Curve





# PDC Quarter-Phased Transit Curves

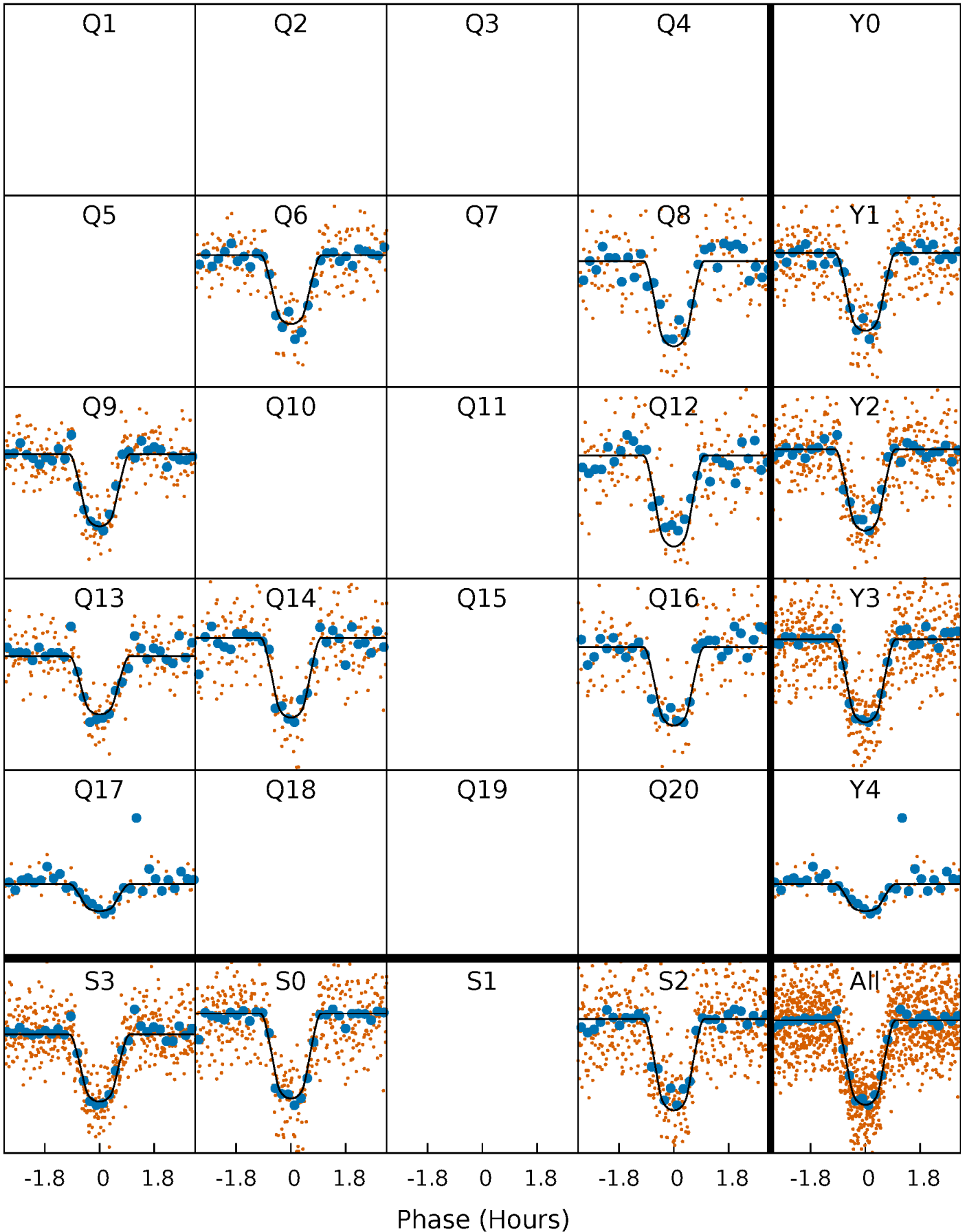
TCE 009730163-01   P= 4.871228 Days    $T_0=133.642062$  (BKJD)





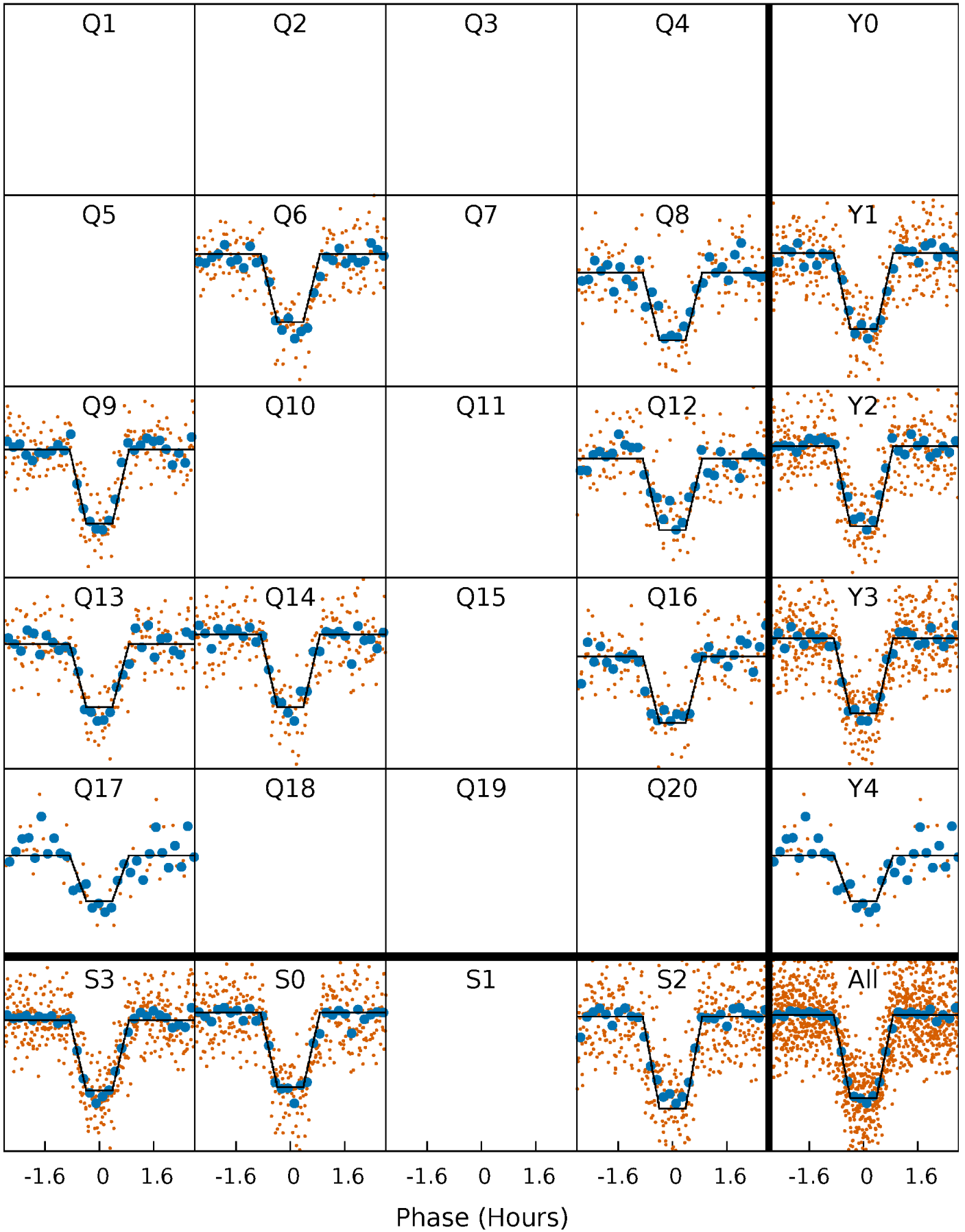
# DV Quarter-Phased Transit Curves

TCE 009730163-01     $P = 4.871228$  Days     $T_0 = 133.642062$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

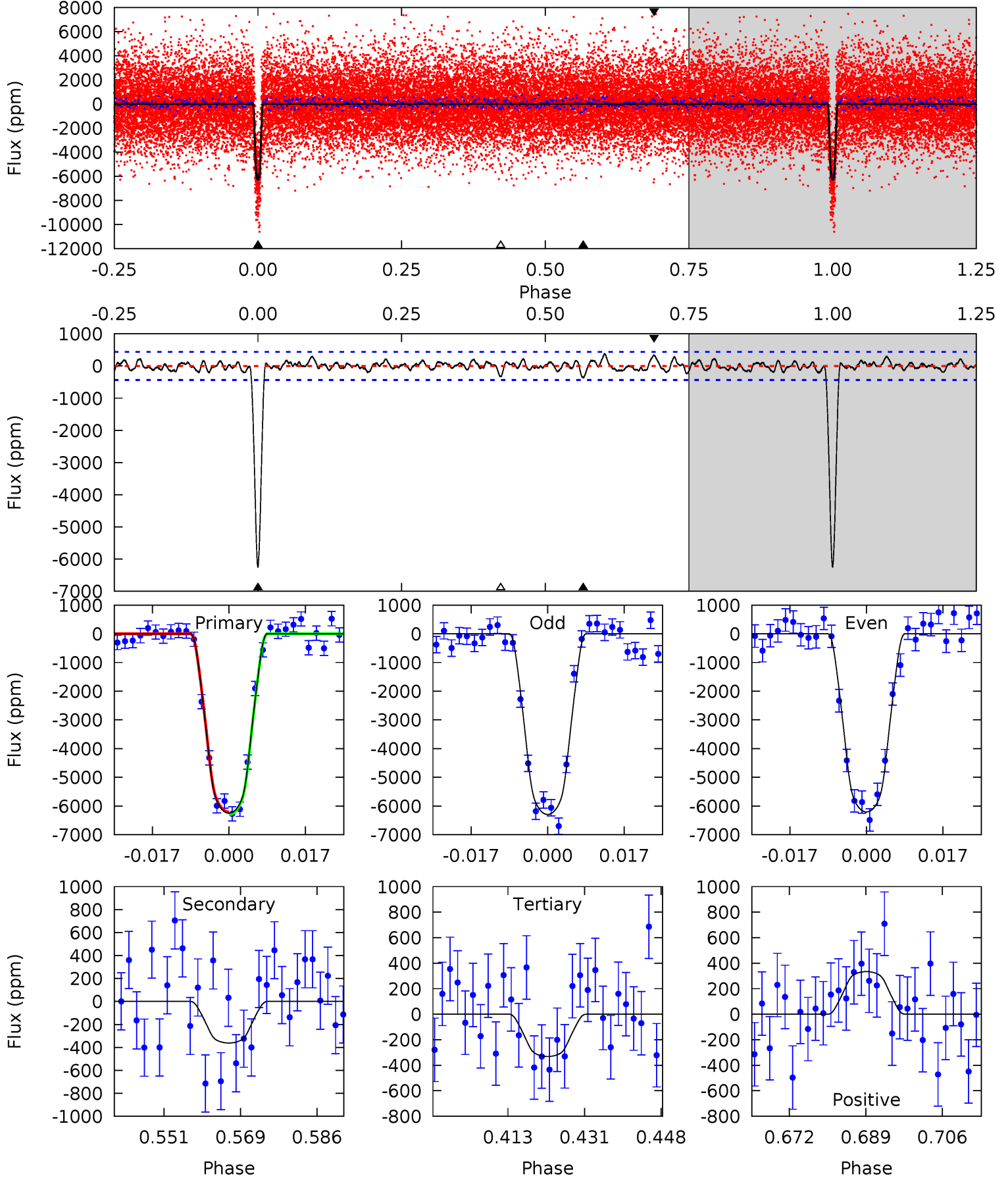
TCE 009730163-01 P= 4.871242 Days  $T_0=133.639150$  (BKJD)



# DV Model-Shift Uniqueness Test

009730163-01, P = 4.871228 Days, E = 133.642062 Days

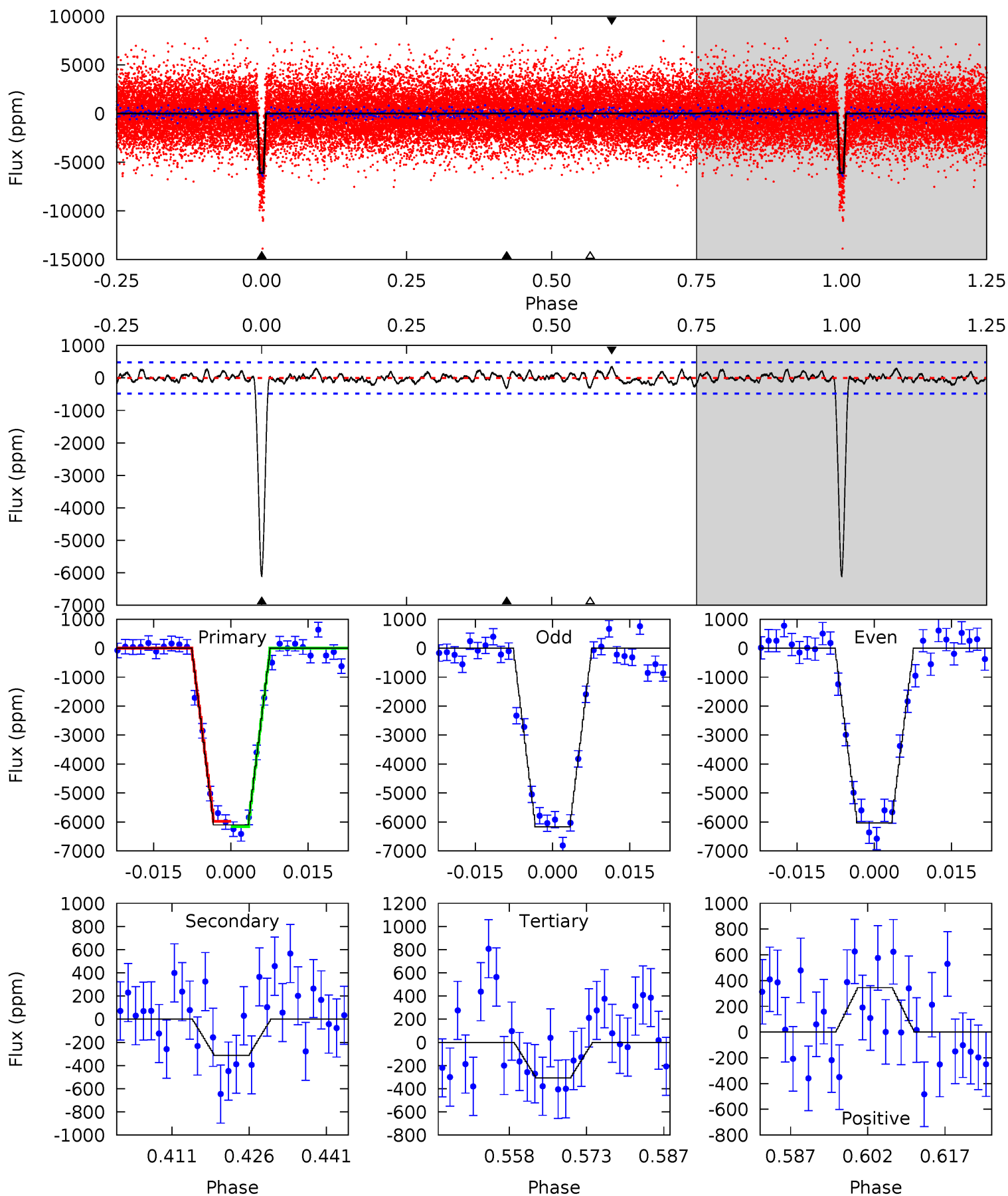
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
70.5	4.08	3.74	3.77	4.92	2.38	1.23	66.8	66.8	0.34	0.32	0.50	0.98	0.06	0.49



# Alt Model-Shift Uniqueness Test

009730163-01, P = 4.871242 Days, E = 133.639150 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
62.9	3.22	3.16	3.56	4.95	2.44	1.12	59.7	59.3	0.06	-0.34	0.67	0.96	0.05	0.97



### Stellar Parameters For KIC 009730163

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R (R_{\odot})$	$M(M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$3157^{+75}_{-37}$	$5.112^{+0.076}_{-0.123}$	$0.260^{+0.150}_{-0.100}$	$0.180^{+0.081}_{-0.027}$	$0.153^{+0.092}_{-0.023}$	$36.920^{+14.980}_{-17.170}$
	+2%/-1%	+1%/-2%	+58%/-38%	+45%/-15%	+60%/-15%	+41%/-47%
Source	SPE86	PHO54	SPE86	DSEP		

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

### Secondary Eclipse Parameters for KIC 009730163-01 / KOI 2704.01

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{max} (K)$	$T_{obs} (K)$	$A_{obs}$
DV	$-362 \pm 89$	$1.52^{+0.40}_{-0.25}$	$481^{+27}_{-19}$	$2214^{+110}_{-93}$	$75^{+42}_{-26}$
Alt.	$-312 \pm 97$	$1.54^{+0.37}_{-0.28}$	$481^{+28}_{-19}$	$2179^{+115}_{-106}$	$63^{+38}_{-23}$

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

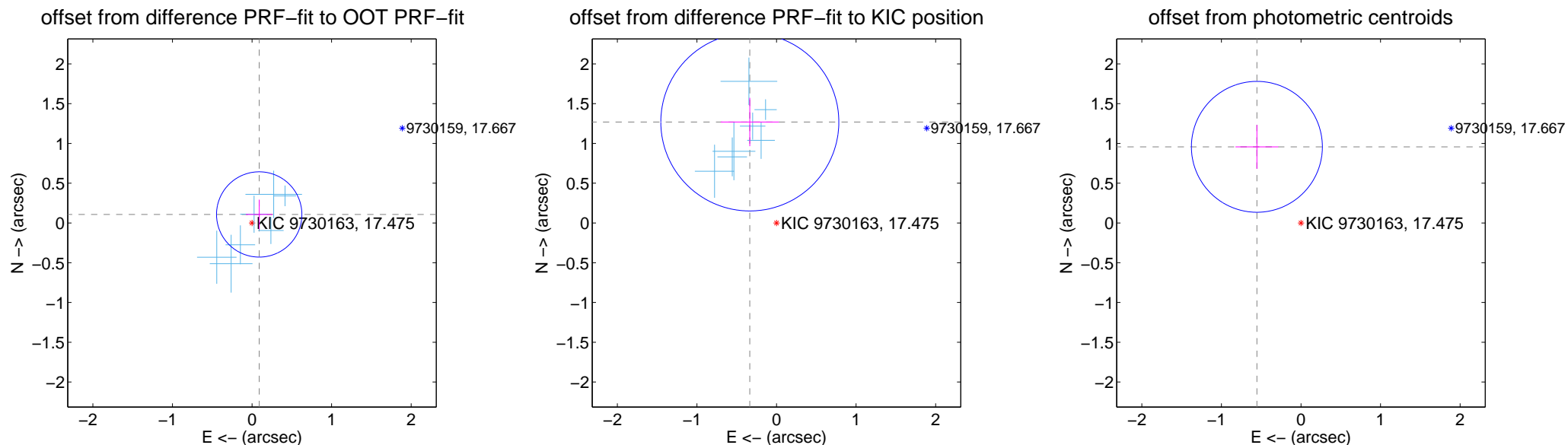
## DV Centroid Data

Supplemental centroid analysis for 009730163-01. Kepler magnitude: 17.48. Transit SNR 47.72

There are 7 quarters with good PRF difference image offsets

The direct PRF centroid is offset from the target star catalog position by about 1.55 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.140 \pm 0.179$	0.78	$-0.090 \pm 0.168$	$0.107 \pm 0.186$
PRF-fit source offset from KIC position	$1.313 \pm 0.373$	3.52	$0.335 \pm 0.366$	$1.270 \pm 0.304$
photometric centroid source offset	$1.11 \pm 0.27$	4.03	$0.55 \pm 0.27$	$0.96 \pm 0.28$



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

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





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

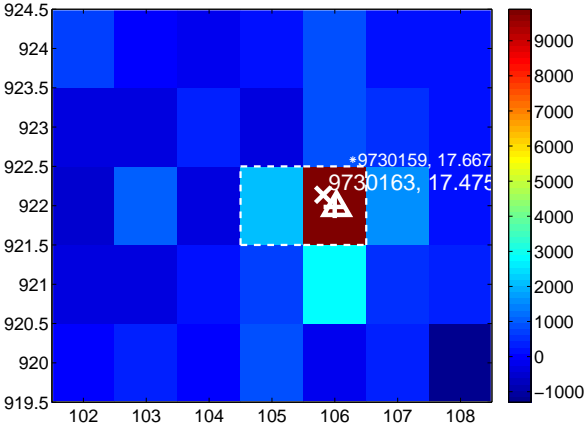
Q5 no difference image



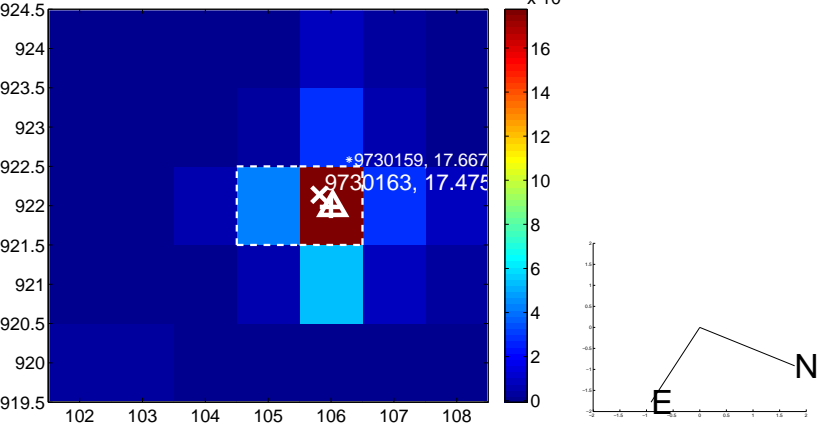
Q5 no OOT image



Q6 difference image



Q6 OOT image



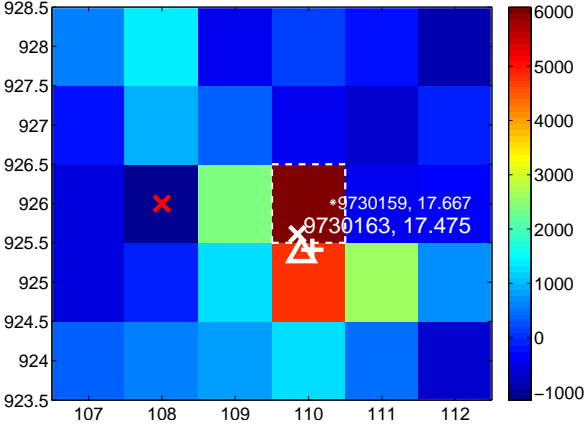
Q7 no difference image



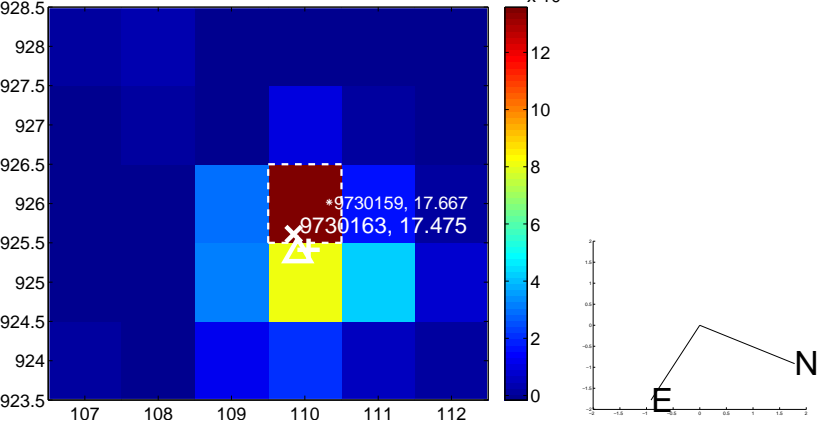
Q7 no OOT image



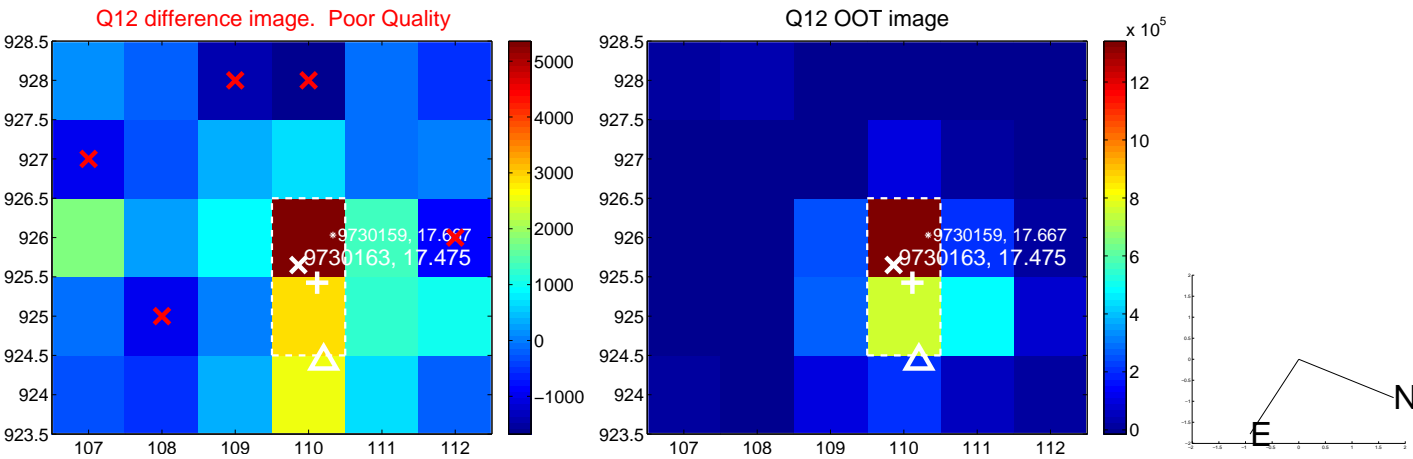
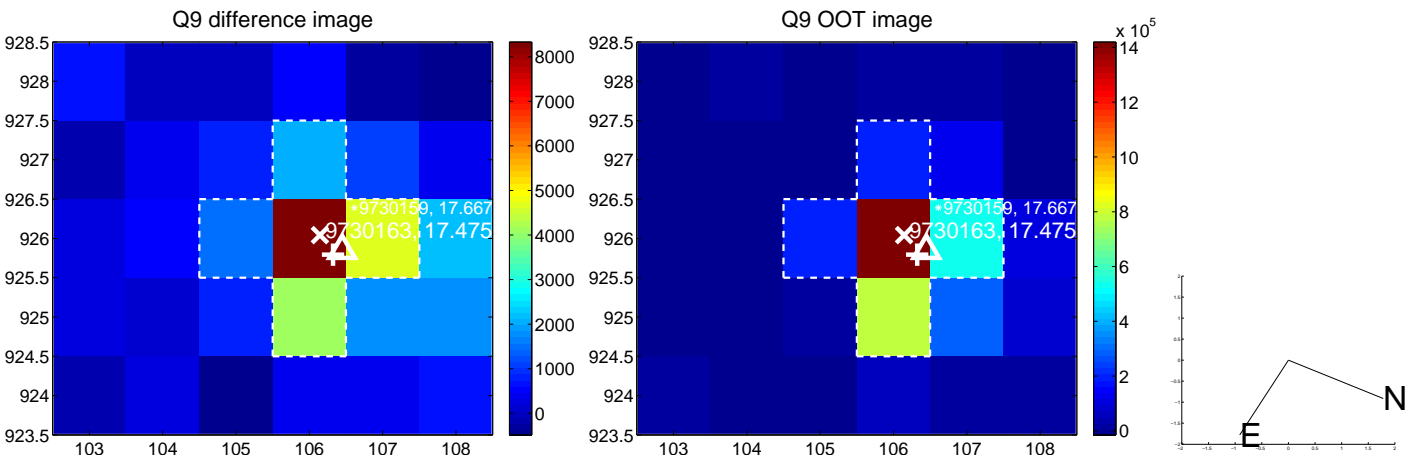
Q8 difference image



Q8 OOT image

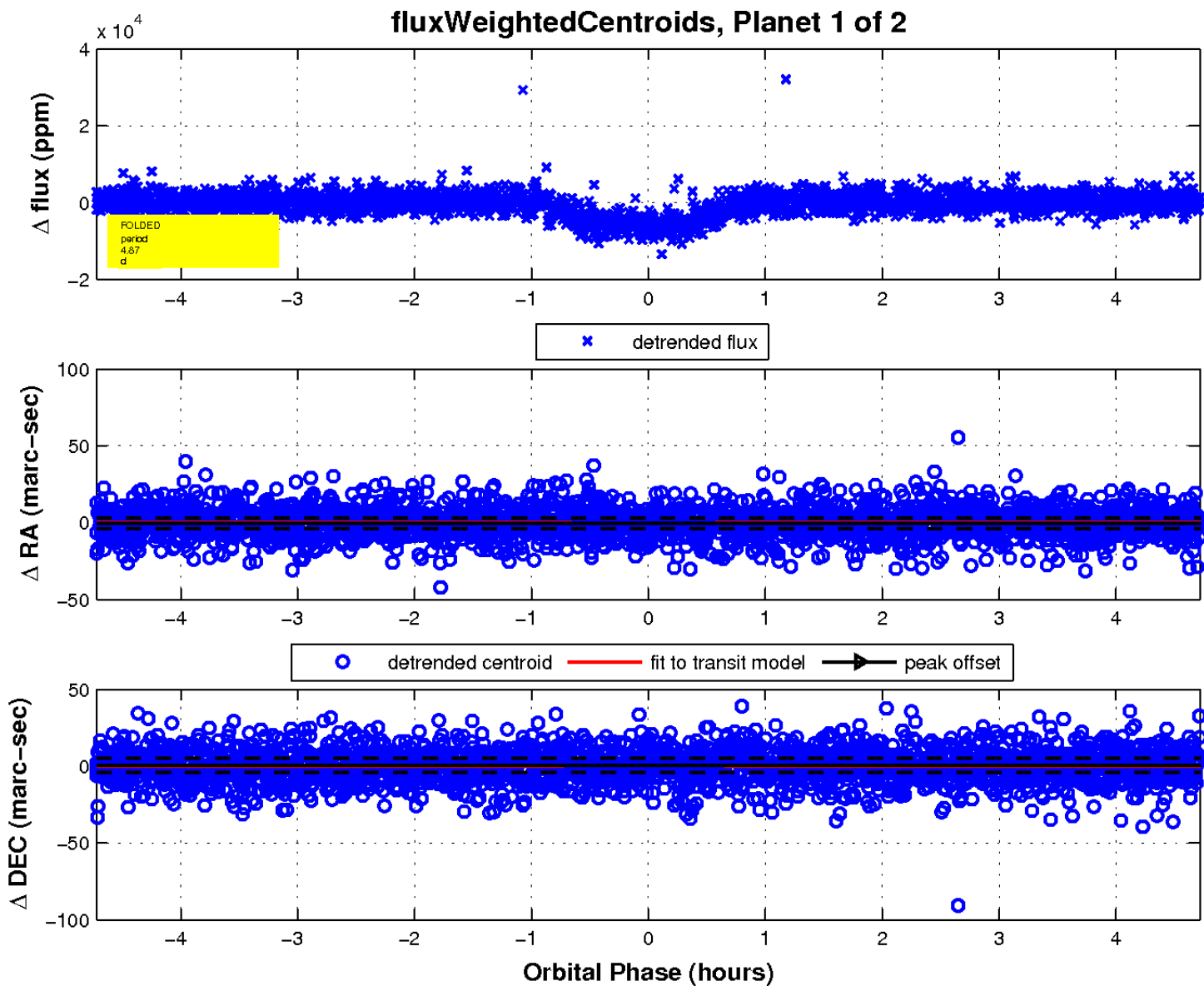
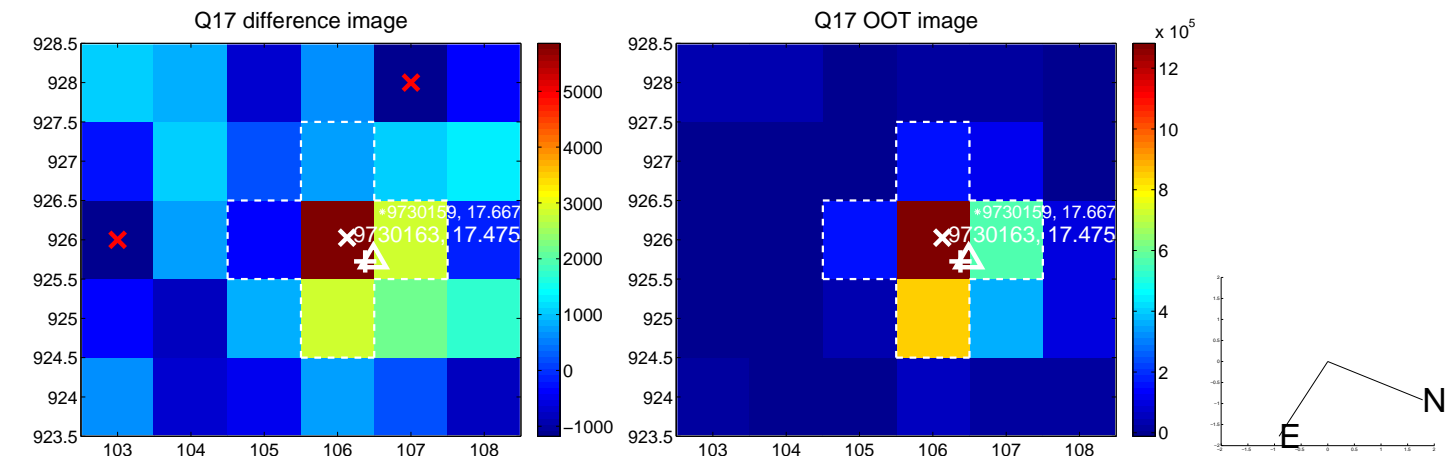


white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



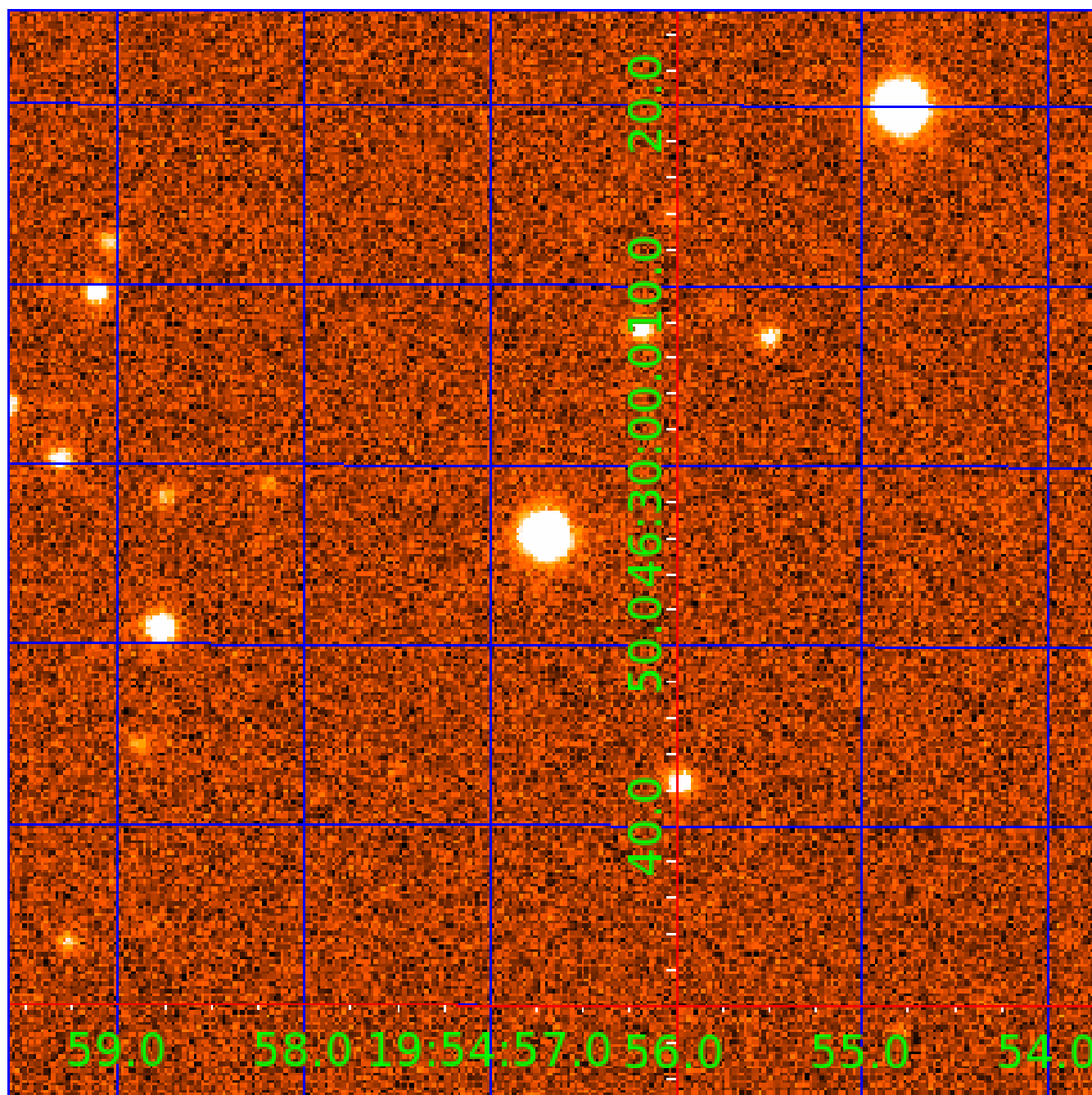


white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



UKIRT Image

Declination



# KIC 009730163

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
009730163-01	OBS	2704.01	4.871228	133.642062	6310.4	1.574	42.0	47.7	0.18	3157	1.52	3.19
009730163-02	OBS	2704.02	2.984148	133.121842	2367.6	1.240	19.5	21.7	0.18	3157	0.89	6.12

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
009730163-01	OBS	PC	1.00	0	0	0	0	CENT_KIC_POS
009730163-02	OBS	PC	0.94	0	0	0	0	CENT_KIC_POS

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

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

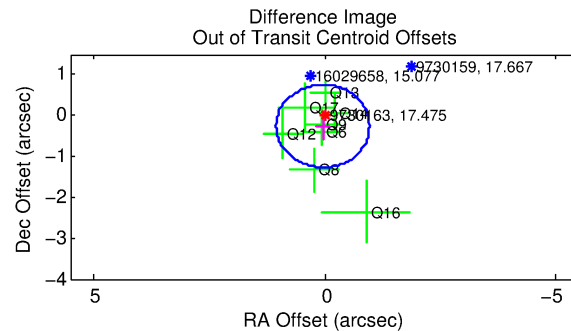
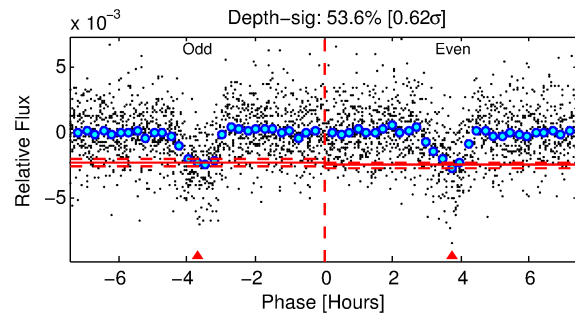
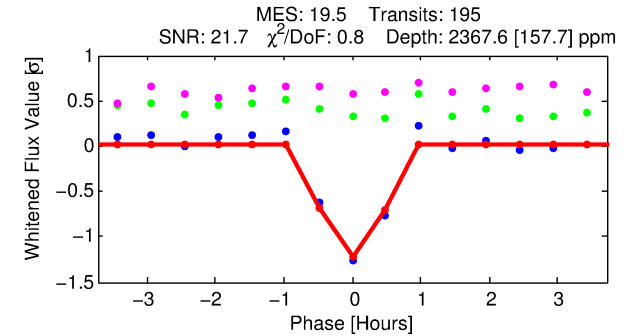
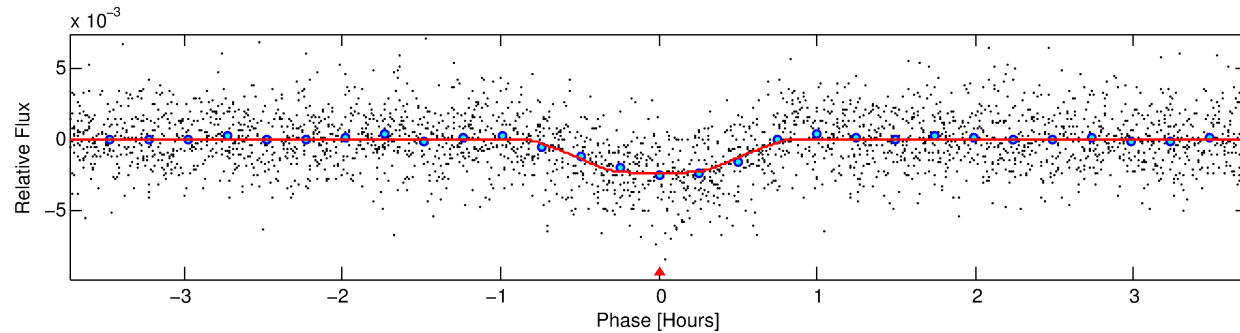
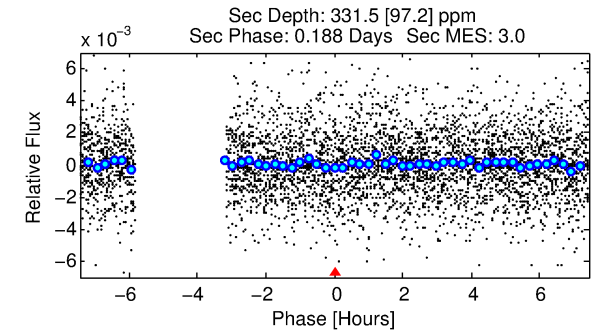
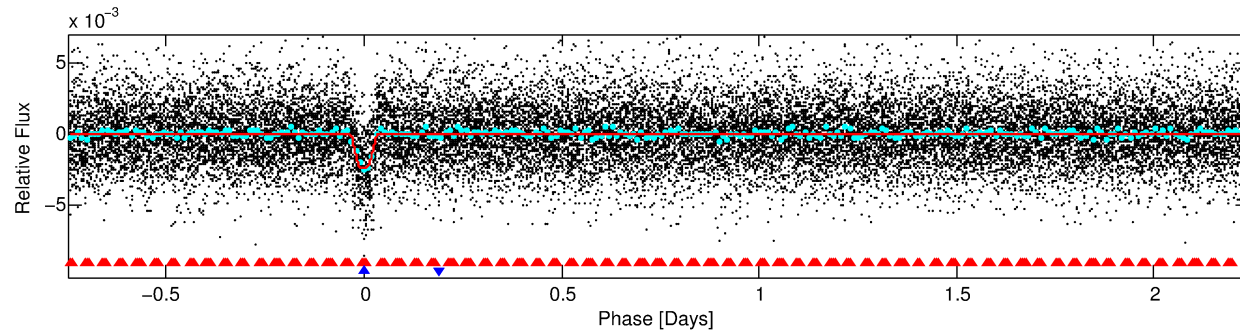
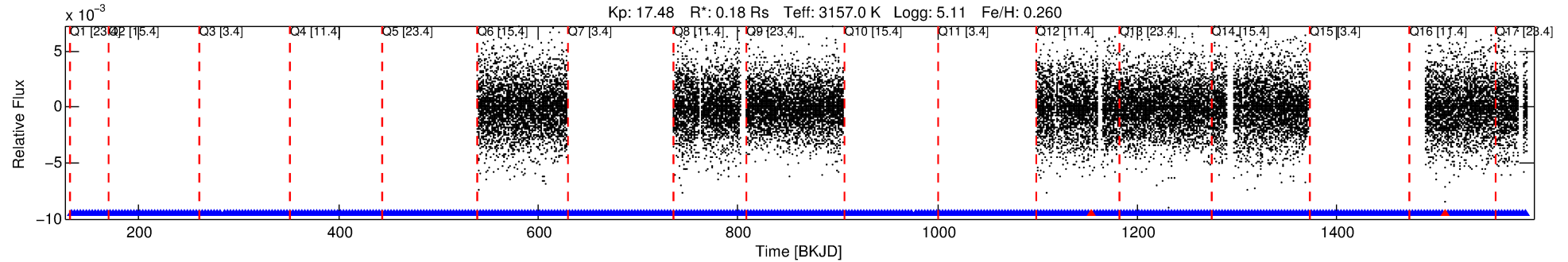
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 009730163-02

No Significant Match Found

# DV One-Page Summary

KIC: 9730163 Candidate: 2 of 2 Period: 2.984 d  
KOI: K02704.02 Name: Kepler-445b Corr: 0.980



## DV Fit Results:

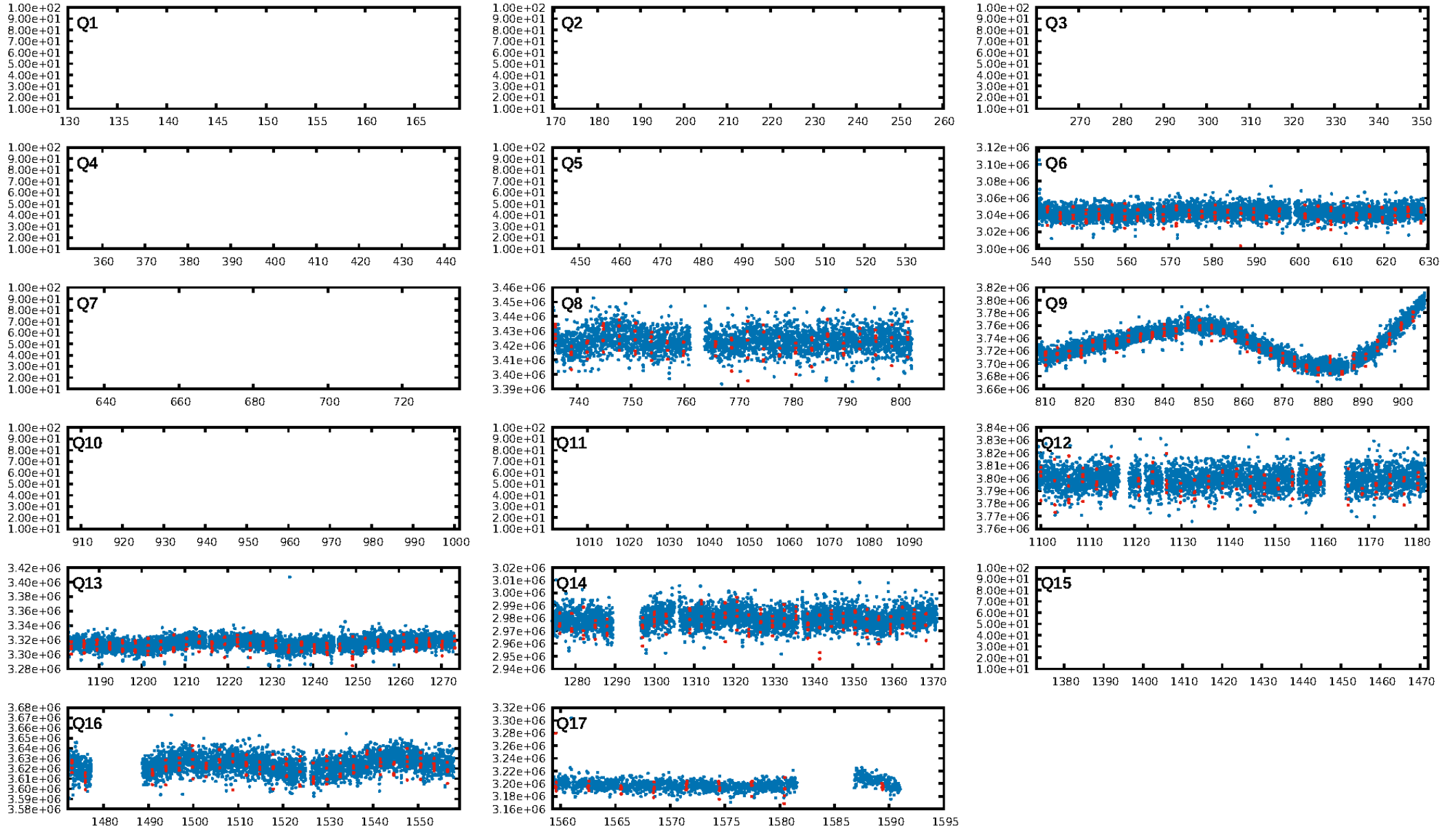
Period = 2.98415 [0.00001] d  
Epoch = 133.1218 [0.0011] BKJD  
Rp/R\* = 0.0455 [0.0379]  
a/R\* = 17.04 [56.32]  
b = 0.49 [5.27]  
Seff = 6.12 [2.25]  
Teq = 401 [37] K  
Rp = 0.89 [0.85] Re  
a = 0.0217 [0.0068] AU  
Ag = 107.51 [186.03] [0.57σ]  
Teffp = 1997 [847] K [1.88σ]

## DV Diagnostic Results:

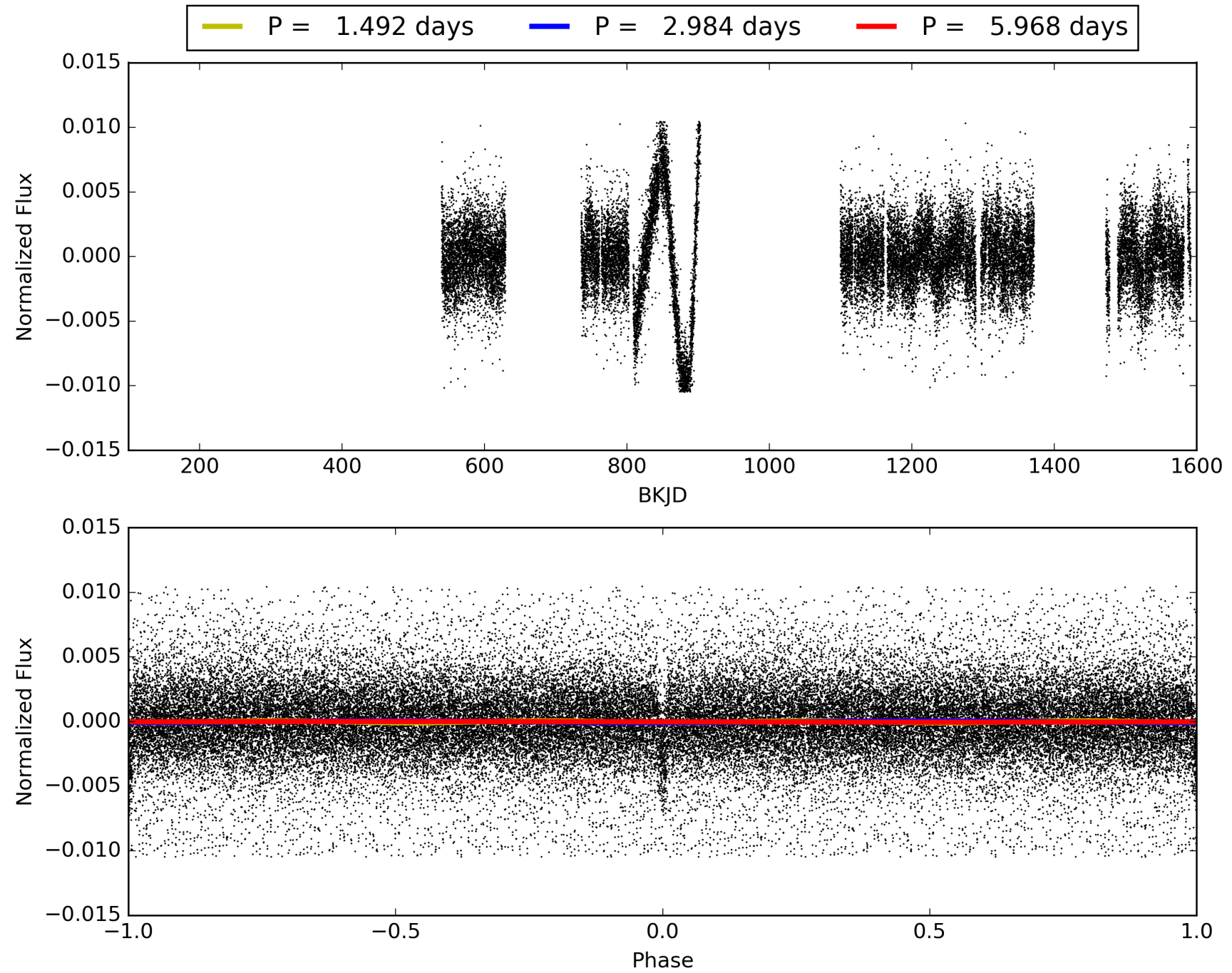
ShortPeriod-sig: N/A  
LongPeriod-sig: 100.0% [22.60σ]  
ModelChiSquare2-sig: 100.0%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 9.71e-83  
RollingBand-fgt: 0.99 [185/187]  
GhostDiagnostic-chr: 2.105  
Centroid-sig: 88.1%  
Centroid-so: 1.259 arcsec [2.05σ]  
OotOffset-rm: 0.260 arcsec [0.77σ]  
OotOffset-st: 2/0/3/3 [8]  
KicOffset-rm: 1.044 arcsec [3.39σ]  
KicOffset-st: 2/0/3/3 [8]  
DiffImageQuality-fgm: 1.00 [8/8]  
DiffImageOverlap-fno: 1.00 [8/8]



# TCE 009730163-02, PDC Light Curves

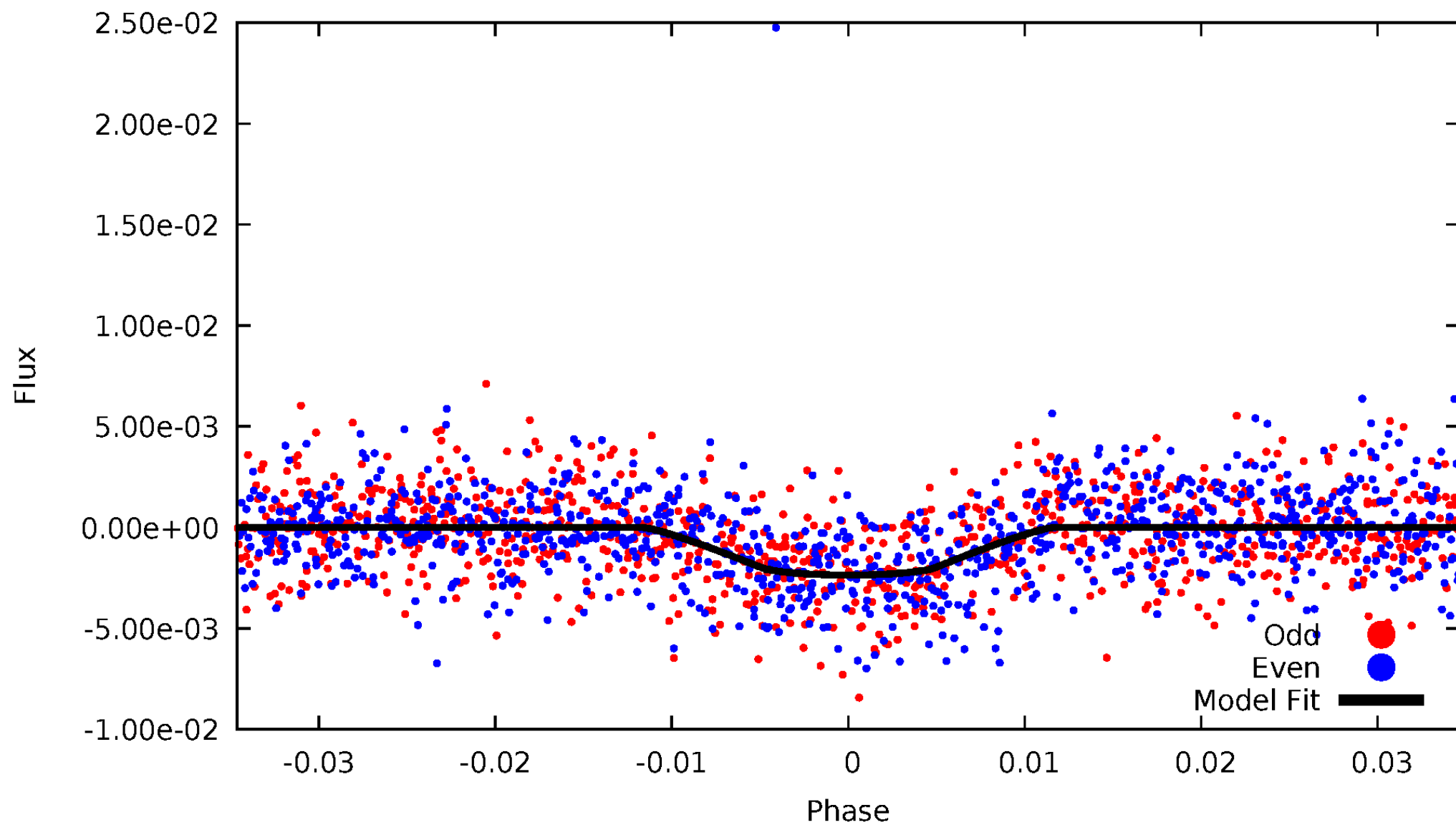


TCE 009730163-02



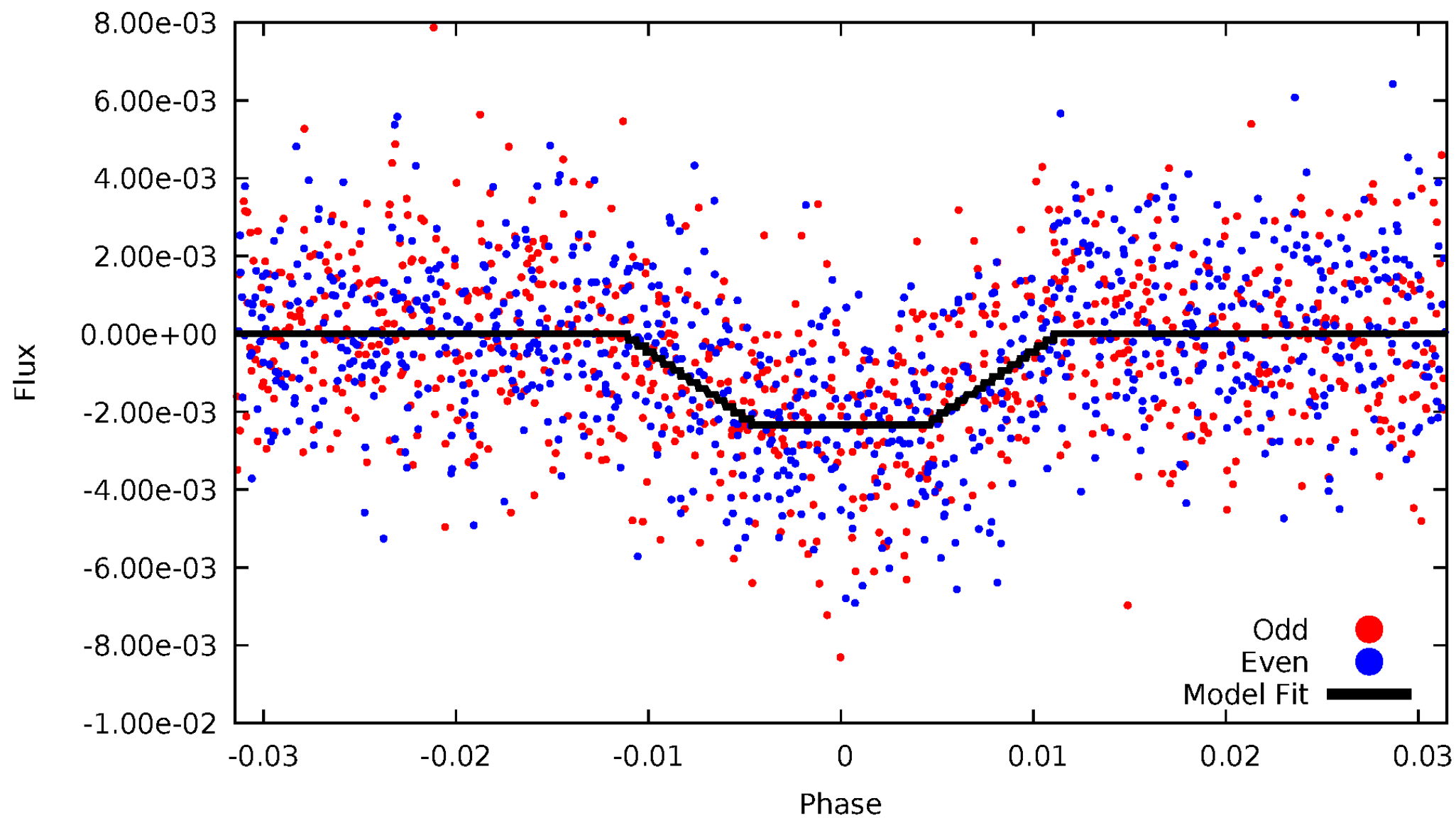
# DV Odd/Even

TCE 009730163-02



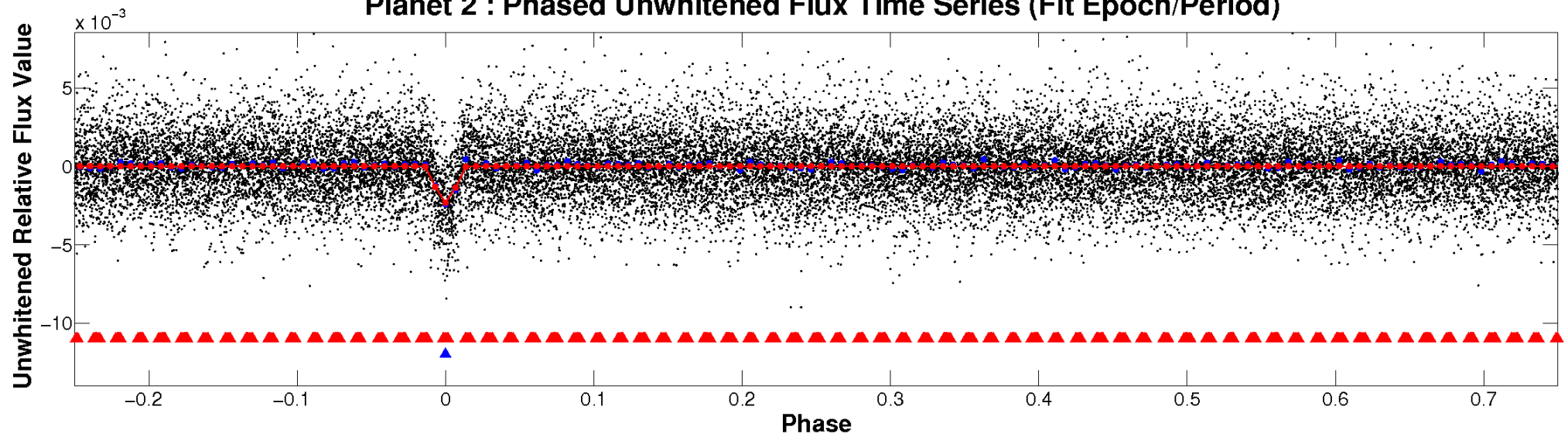
# ALT Odd/Even

TCE 009730163-02

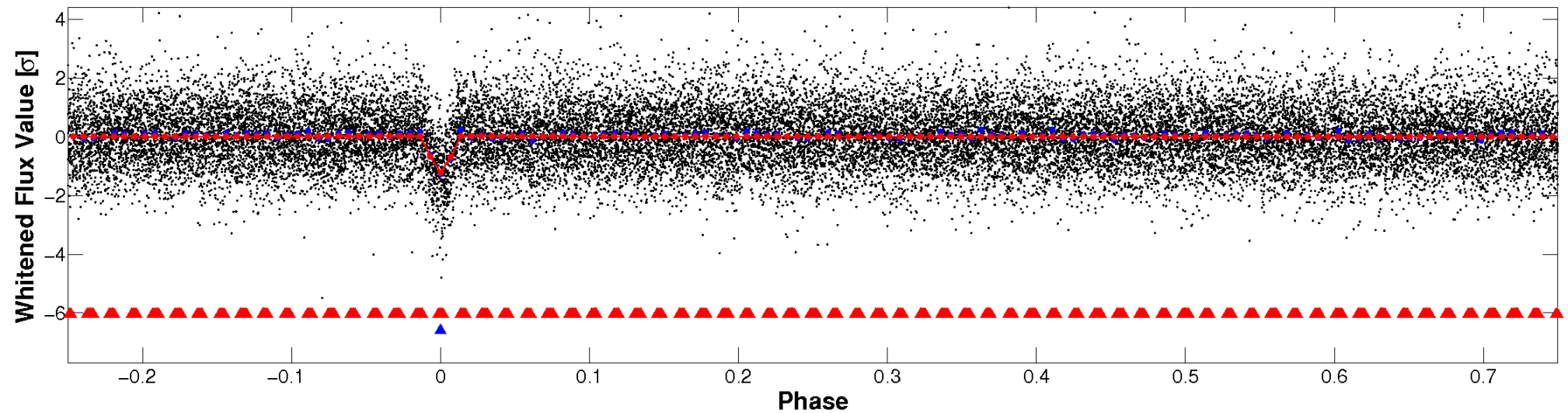


# Non-Whitened Vs. Whitened Light Curve

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

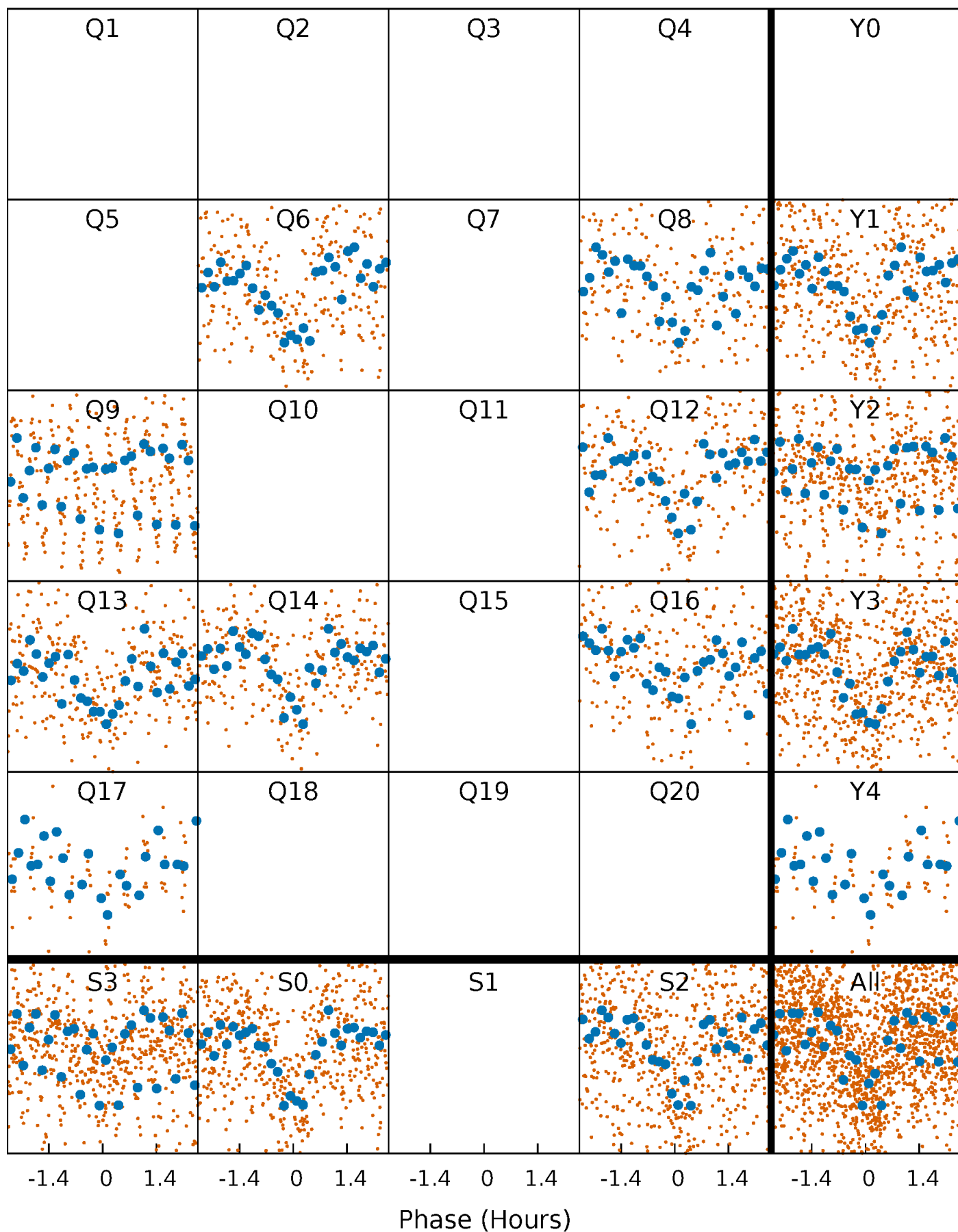


## Planet 2 : Phased Whitened Flux Time Series (Fit Epoch/Period)



# PDC Quarter-Phased Transit Curves

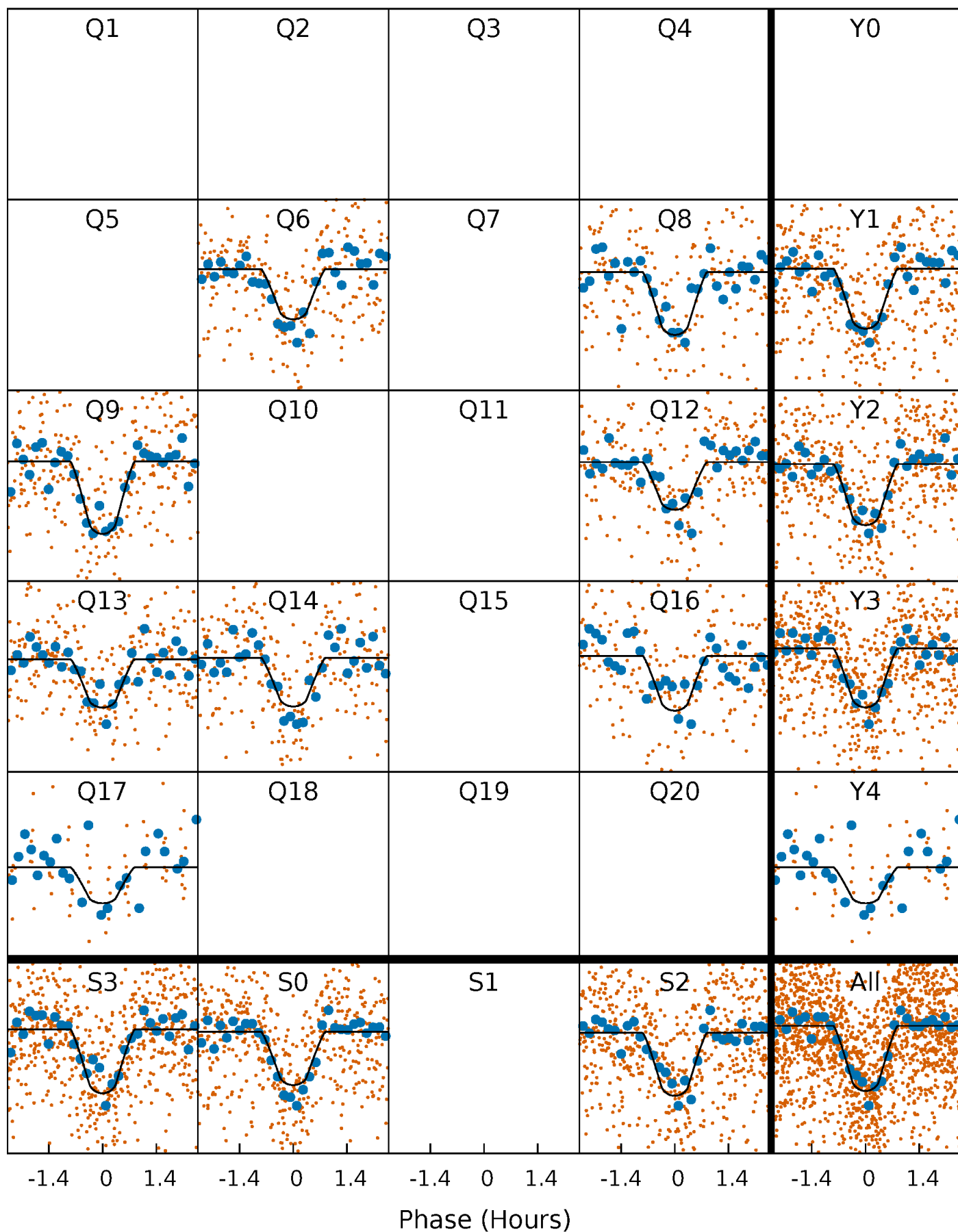
TCE 009730163-02   P= 2.984148 Days    $T_0=133.121842$  (BKJD)





# DV Quarter-Phased Transit Curves

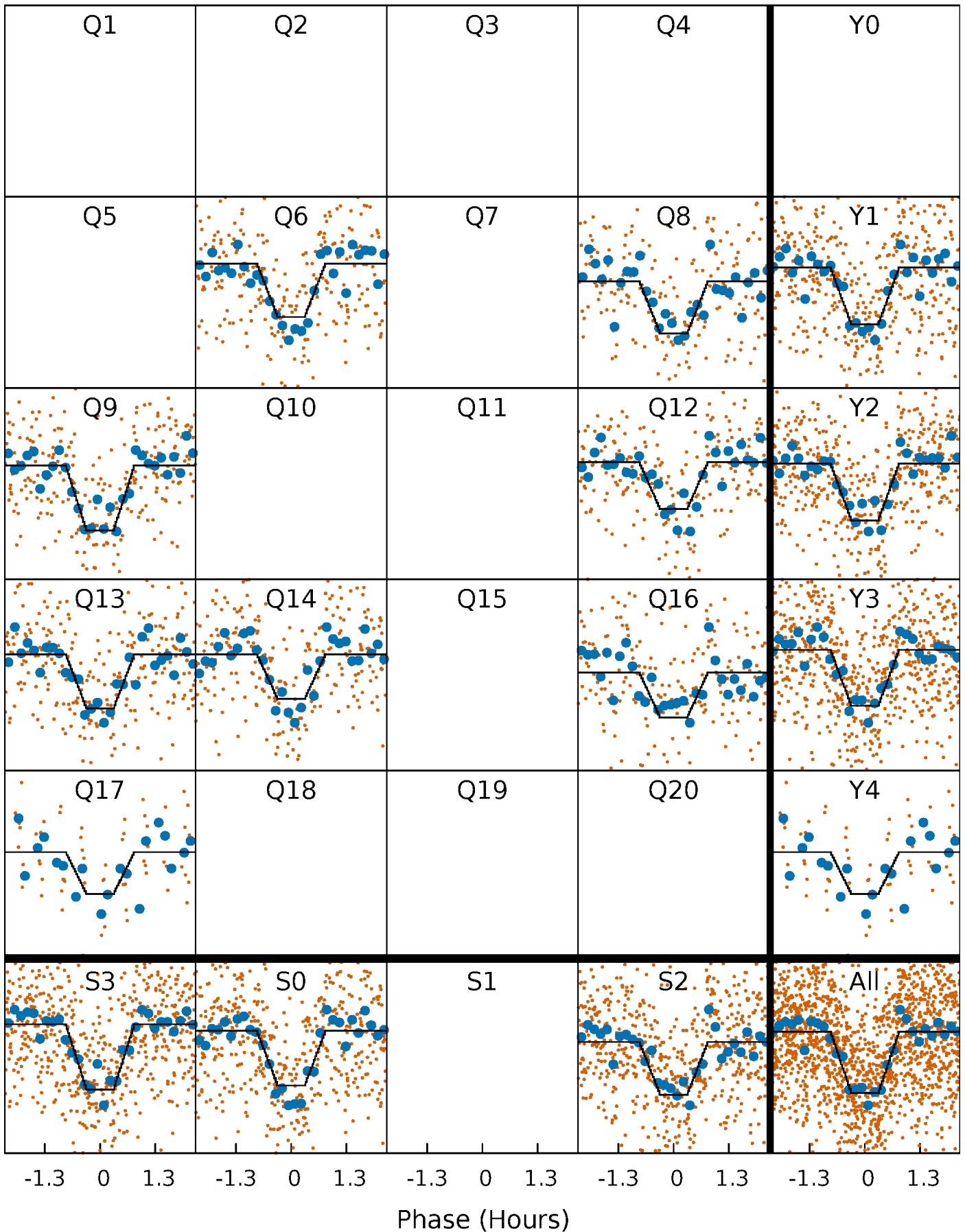
TCE 009730163-02   P= 2.984148 Days    $T_0=133.121842$  (BKJD)





# Alt. Detrend Quarter-Phased Transit Curves

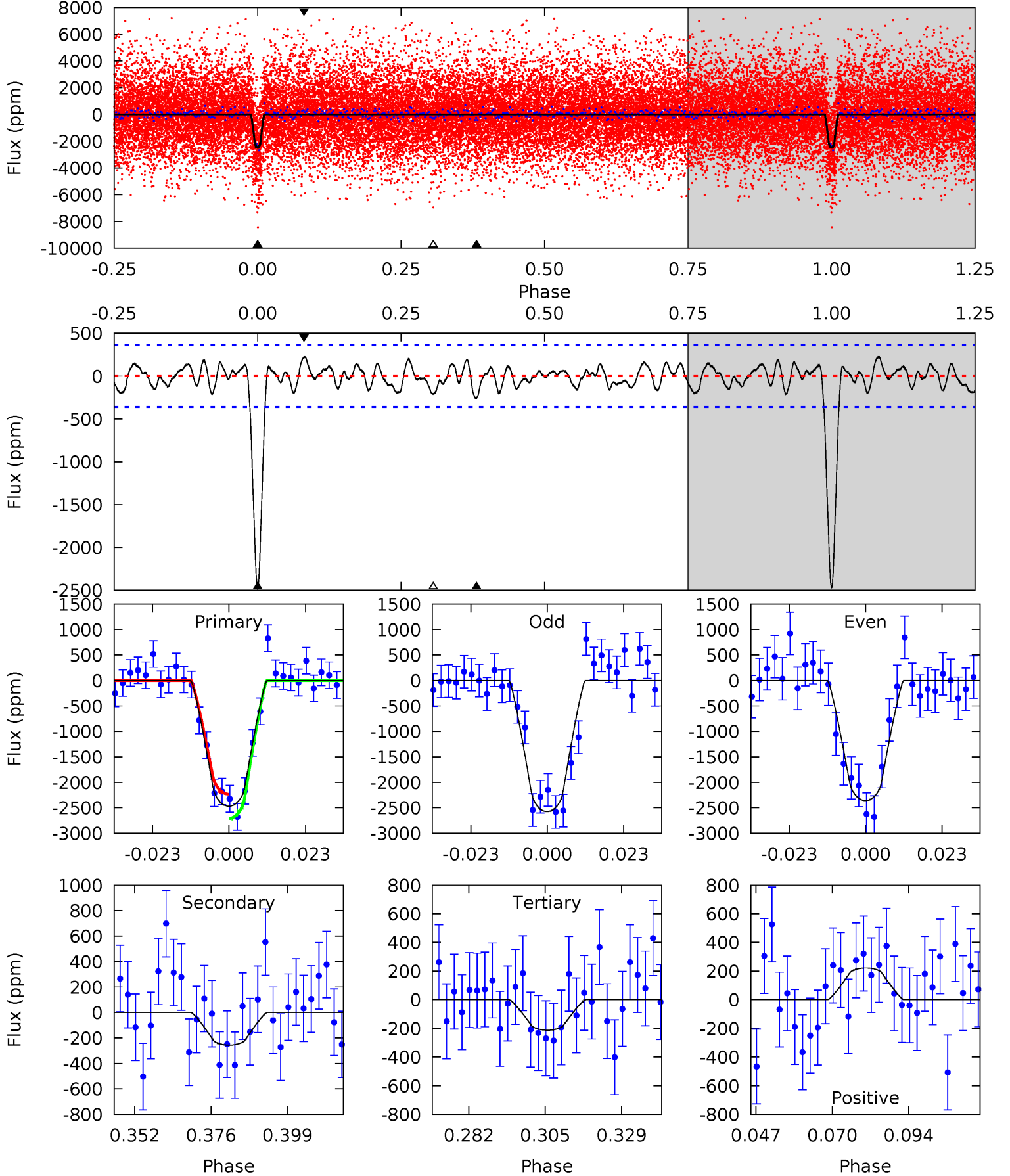
TCE 009730163-02 P= 2.984158 Days  $T_0=133.118806$  (BKJD)



# DV Model-Shift Uniqueness Test

009730163-02, P = 2.984148 Days, E = 133.121842 Days

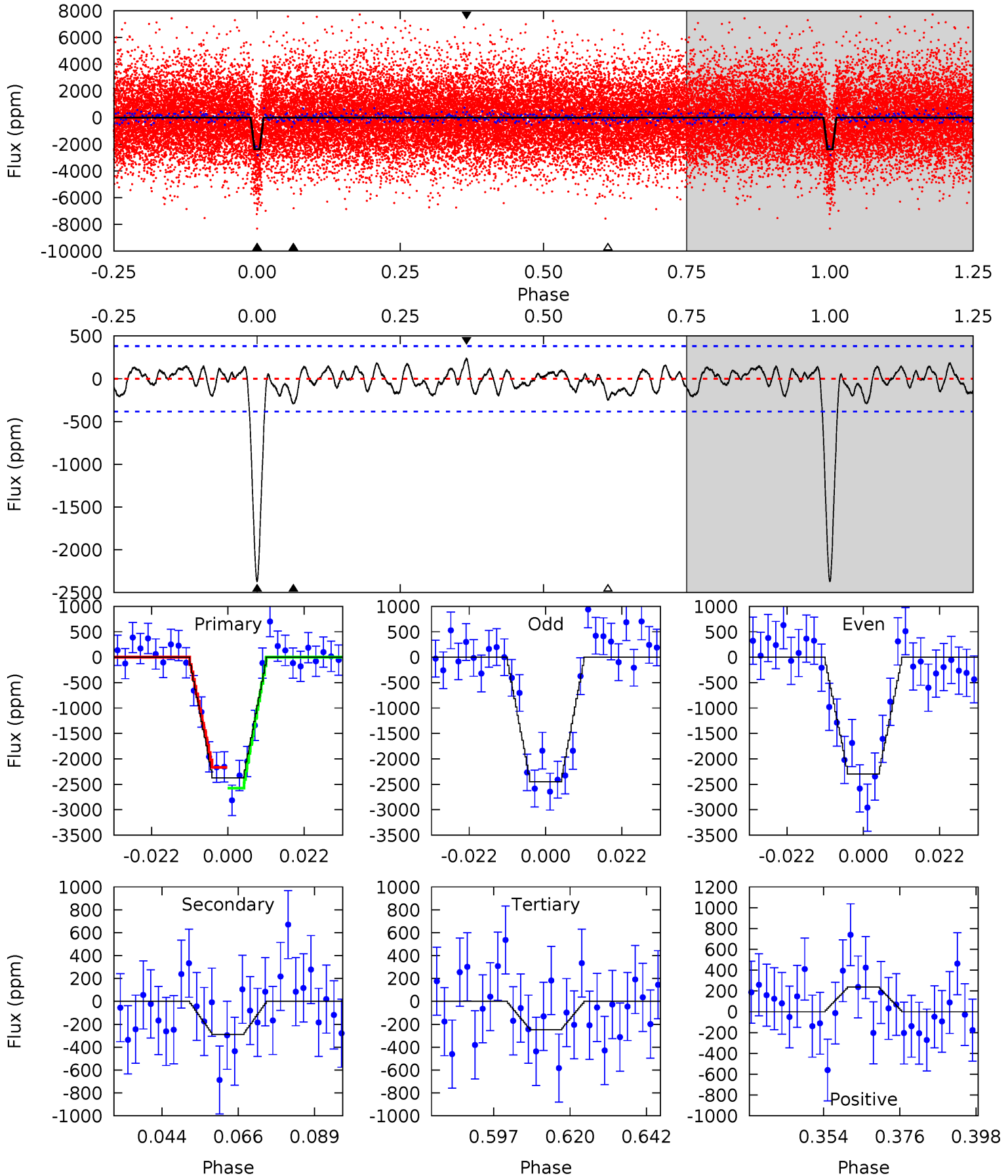
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
33.2	3.44	2.85	2.98	4.86	2.27	1.31	30.3	30.2	0.59	0.46	1.46	0.99	0.08	3.21



# Alt Model-Shift Uniqueness Test

009730163-02, P = 2.984158 Days, E = 133.118806 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
30.2	3.68	3.16	3.02	4.87	2.29	1.24	27.0	27.2	0.52	0.66	0.96	0.96	0.09	2.61



### Stellar Parameters For KIC 009730163

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R$ ( $R_{\odot}$ )	$M$ ( $M_{\odot}$ )	$p_{\star}$ ( $\text{g}\cdot\text{cm}^{-3}$ )
	$3157^{+75}_{-37}$	$5.112^{+0.076}_{-0.123}$	$0.260^{+0.150}_{-0.100}$	$0.180^{+0.081}_{-0.027}$	$0.153^{+0.092}_{-0.023}$	$36.920^{+14.980}_{-17.170}$
	+2%/-1%	+1%/-2%	+58%/-38%	+45%/-15%	+60%/-15%	+41%/-47%
Source	SPE86	PHO54	SPE86	DSEP		

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

### Secondary Eclipse Parameters for KIC 009730163-02 / KOI 2704.02

Detrend	Depth (ppm)	$R_p$ ( $R_{\oplus}$ )	$T_{\text{max}}$ (K)	$T_{\text{obs}}$ (K)	$A_{\text{obs}}$
DV	$-256 \pm 74$	$1.05^{+0.78}_{-0.64}$	$568^{+32}_{-23}$	$2339^{+658}_{-280}$	$61^{+342}_{-42}$
Alt.	$-289 \pm 79$	$1.06^{+0.79}_{-0.62}$	$567^{+33}_{-23}$	$2366^{+577}_{-279}$	$67^{+325}_{-46}$

$T_{\text{max}}$  = 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

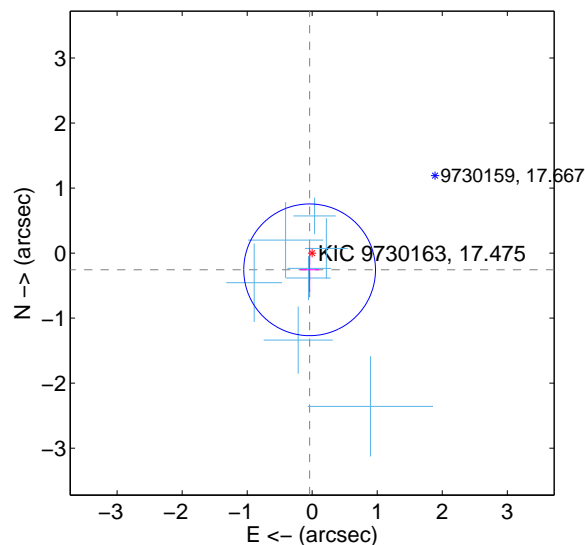
Supplemental centroid analysis for 009730163-02. Kepler magnitude: 17.48. Transit SNR 21.74

There are 8 quarters with good PRF difference image offsets

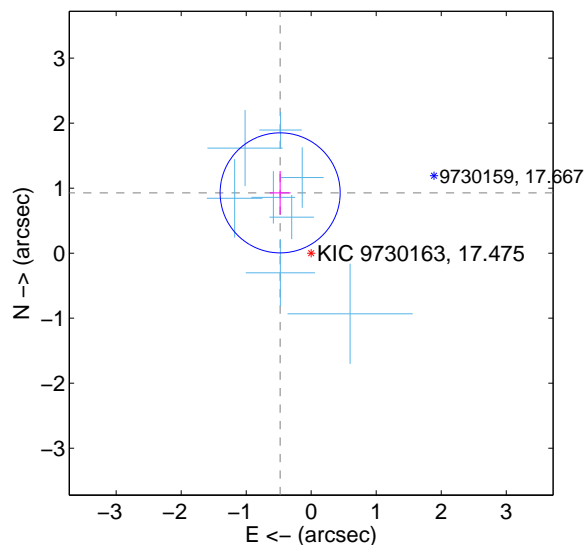
The direct PRF centroid is offset from the target star catalog position by about 1.54 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.260 \pm 0.338$	0.77	$0.040 \pm 0.146$	$-0.257 \pm 0.341$
PRF-fit source offset from KIC position	<b><math>1.044 \pm 0.308</math></b>	<b>3.39</b>	$0.478 \pm 0.161$	$0.928 \pm 0.336$
photometric centroid source offset	$1.26 \pm 0.61$	2.05	$0.73 \pm 0.60$	$1.03 \pm 0.62$

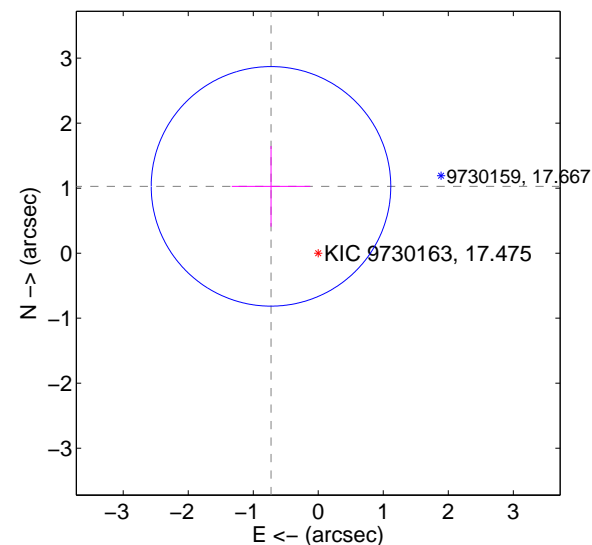
offset from difference PRF-fit to OOT PRF-fit



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.



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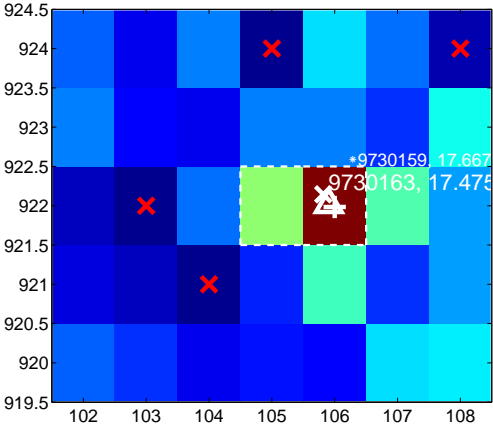
Q5 no difference image



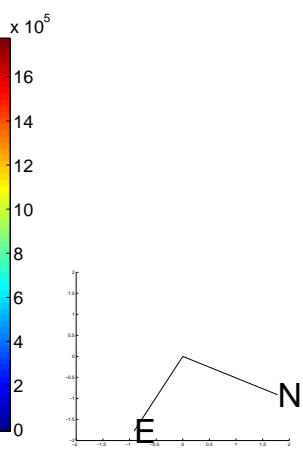
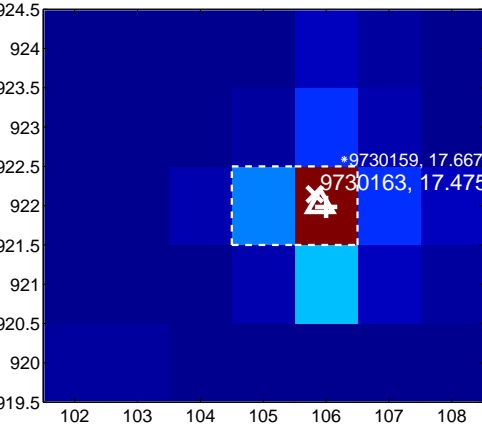
Q5 no OOT image



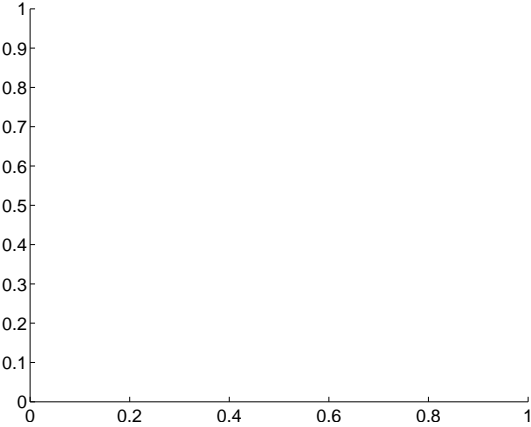
Q6 difference image



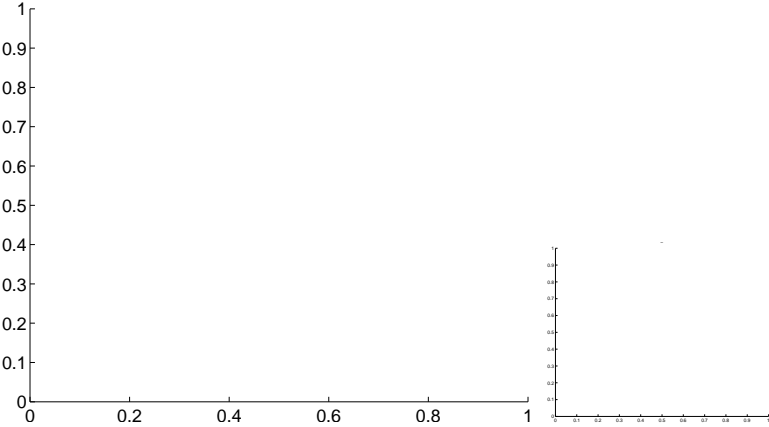
Q6 OOT image



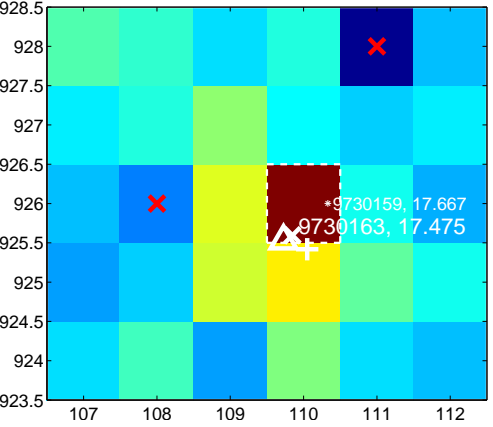
Q7 no difference image



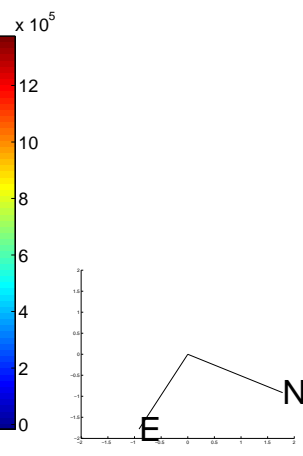
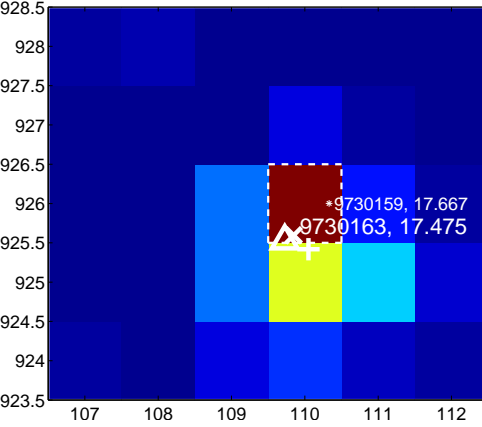
Q7 no OOT image



Q8 difference image

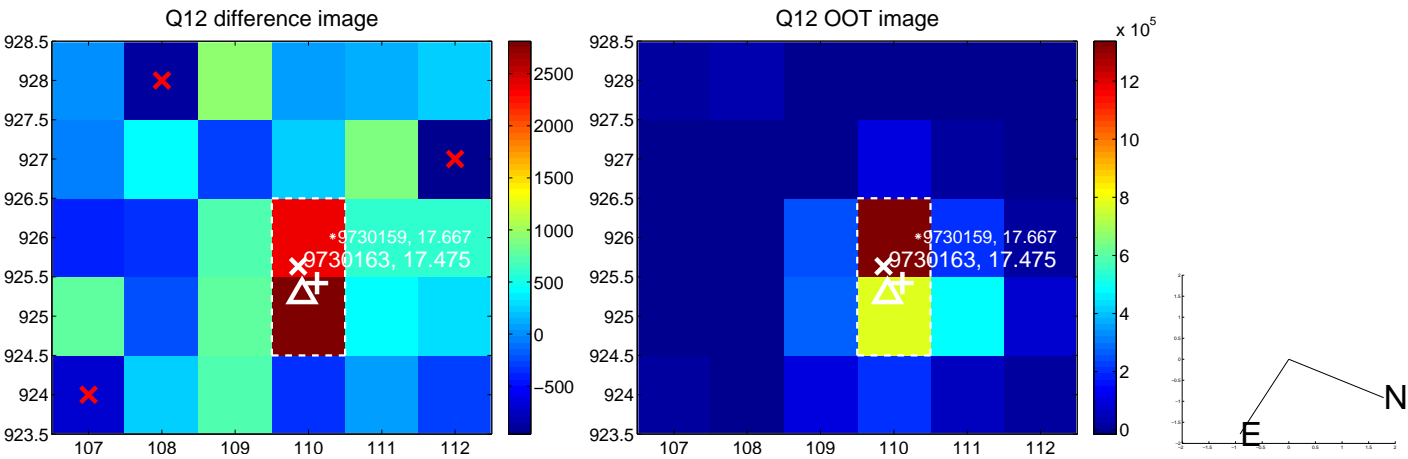
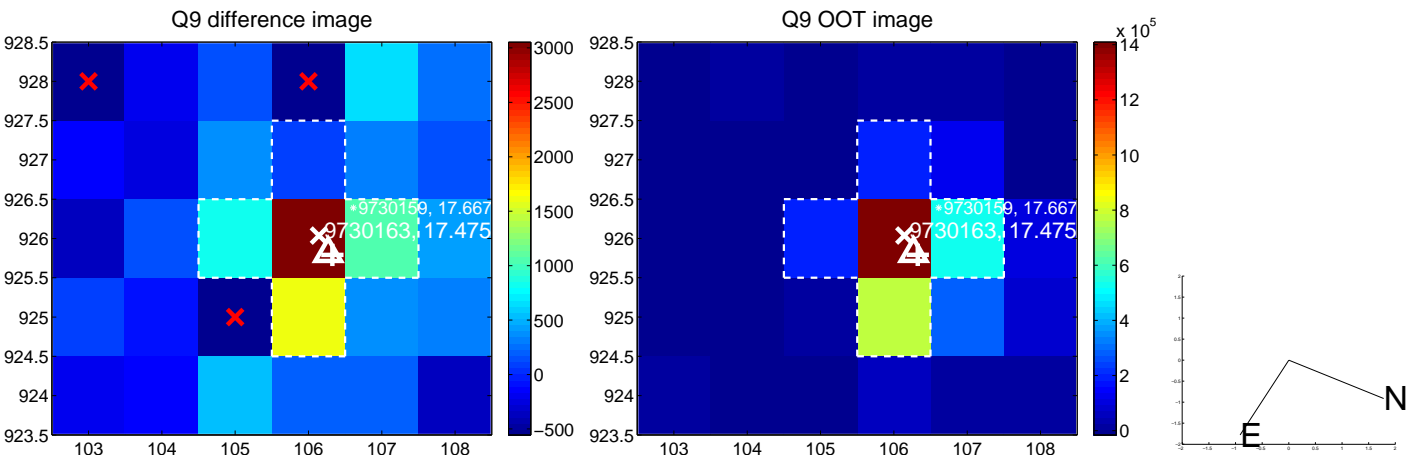


Q8 OOT image

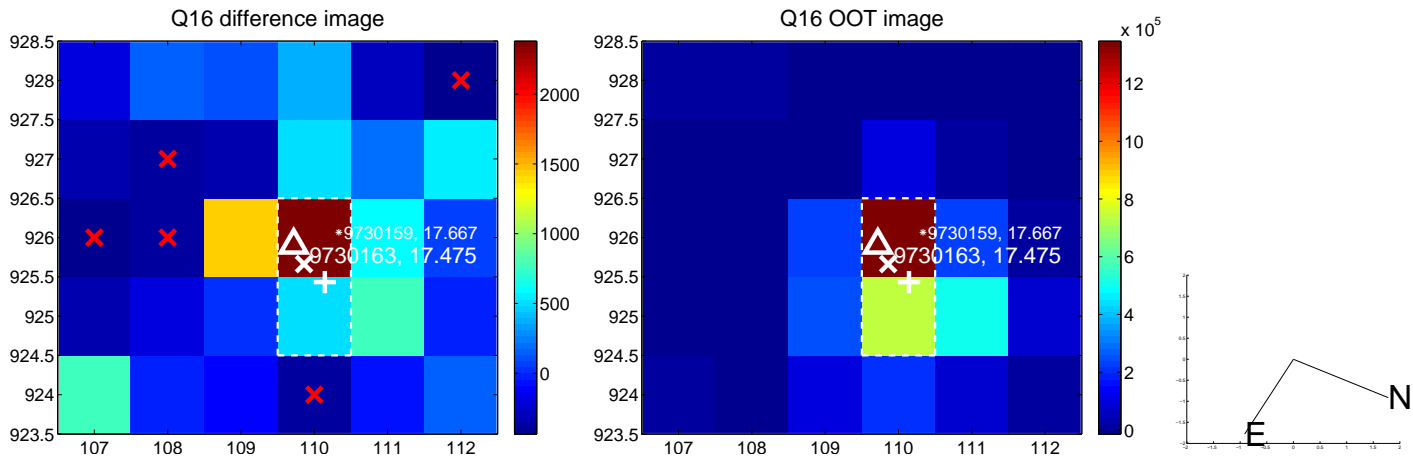
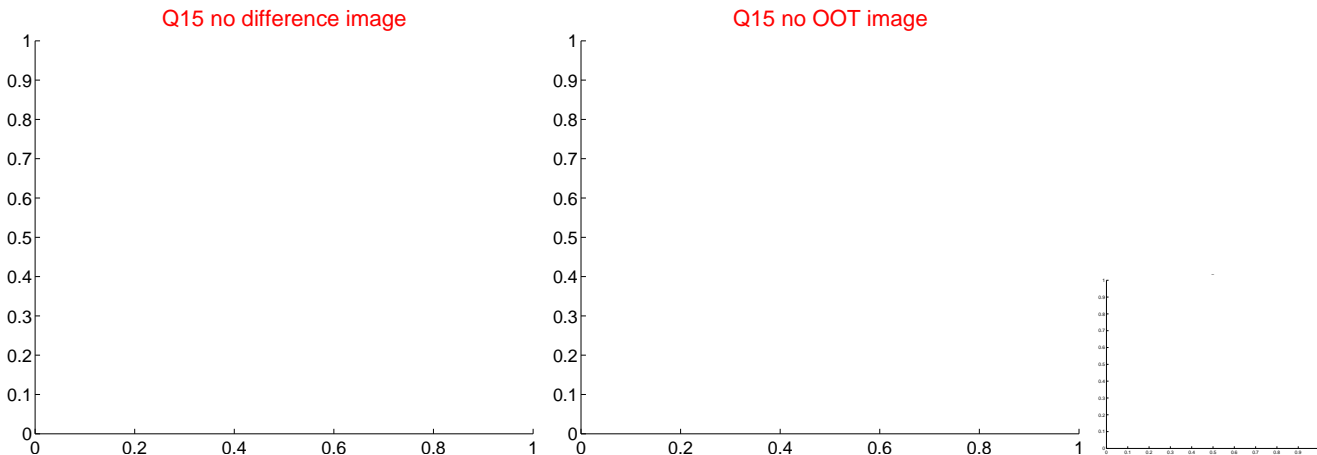
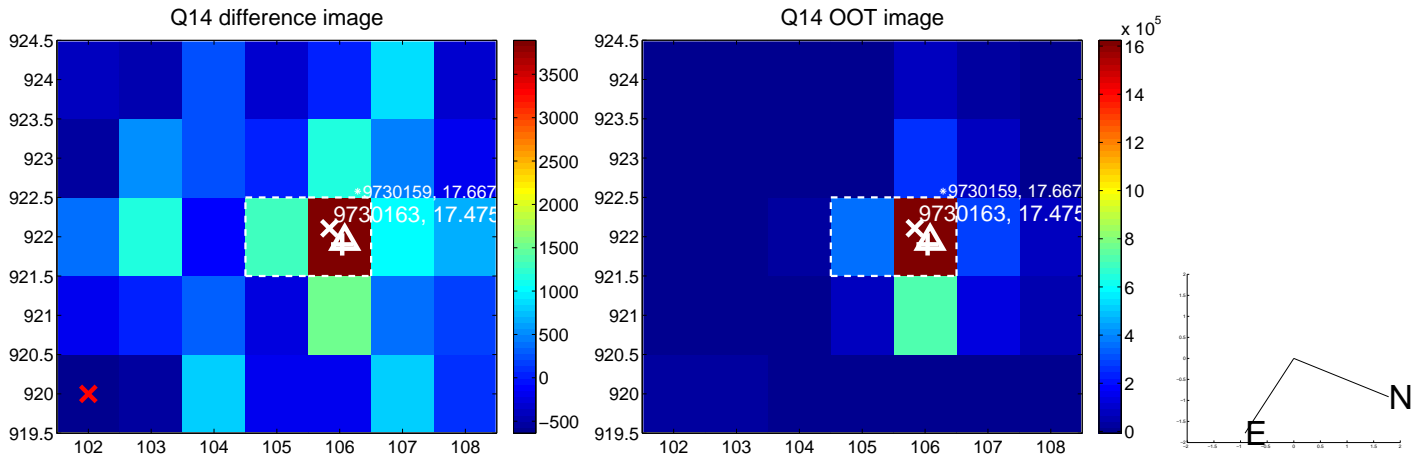
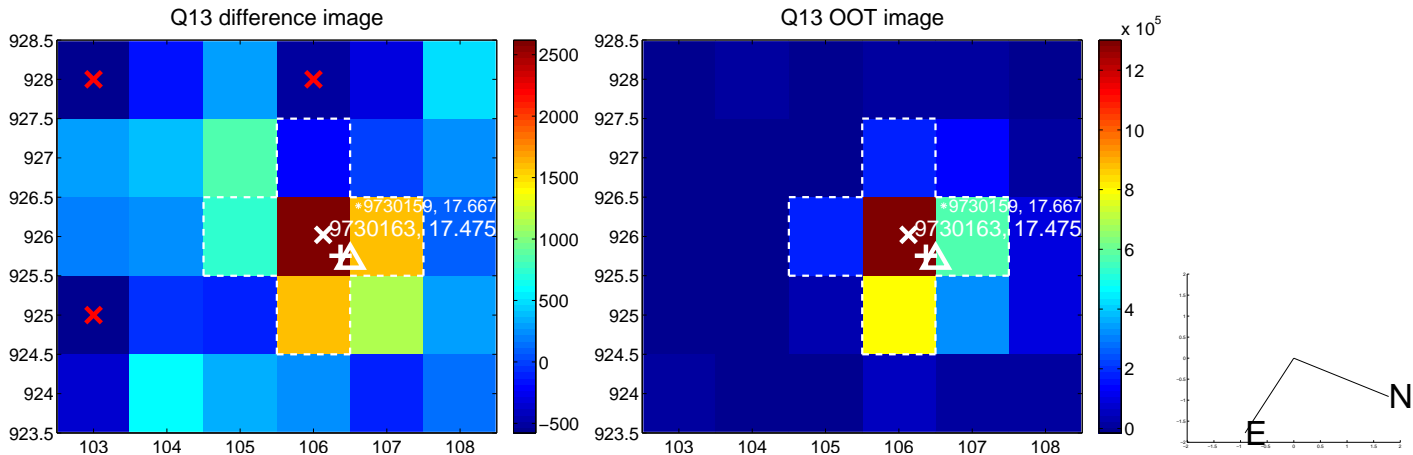




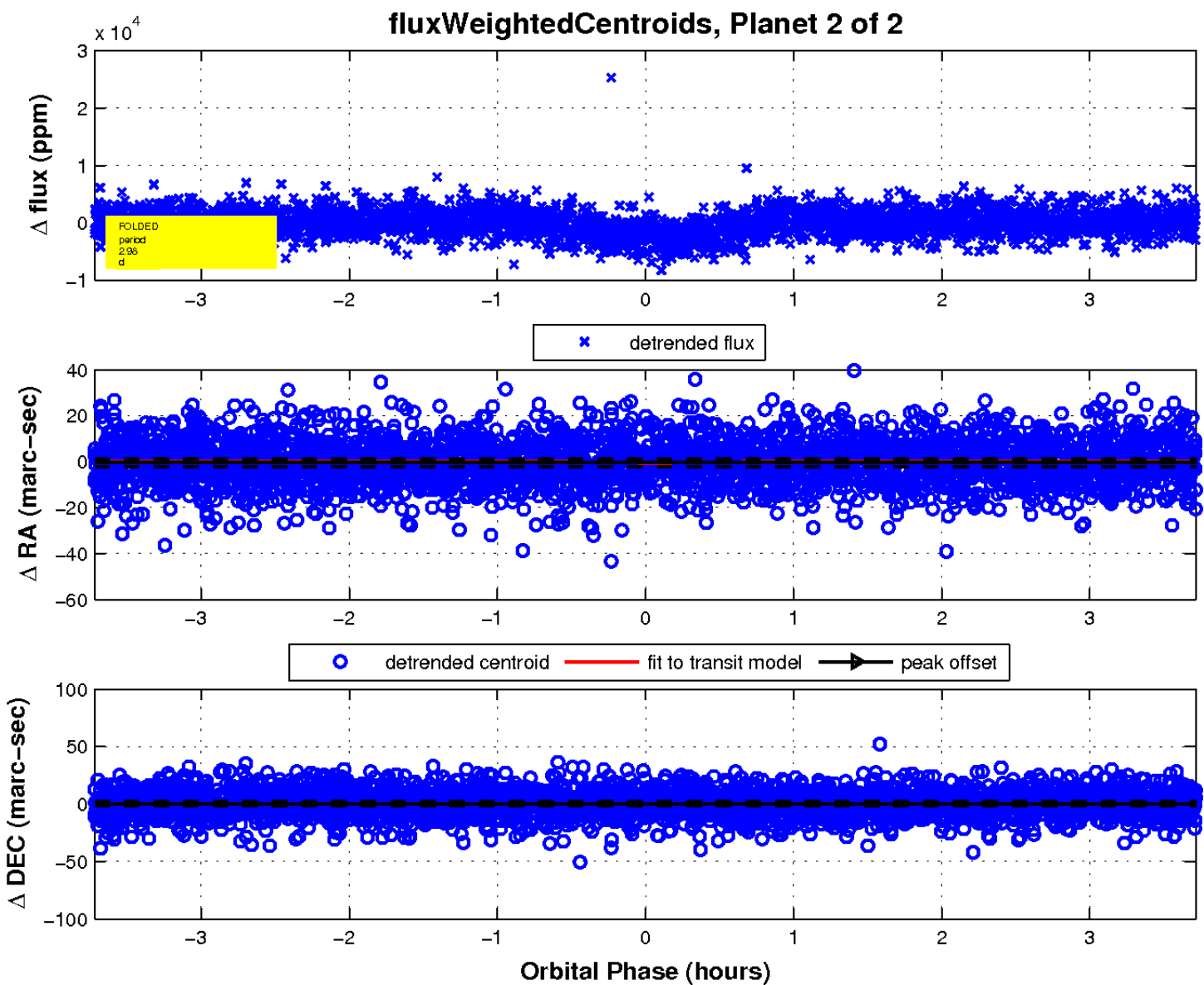
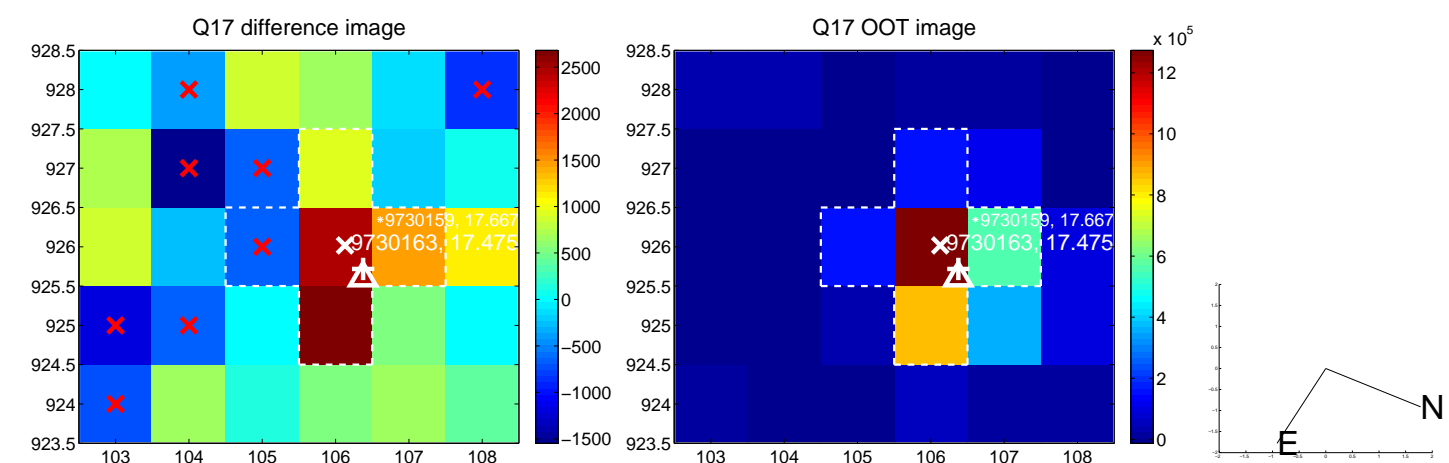
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UKIRT Image

Declination

