

# KIC 012306058

## 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) | $R_p$ ( $R_{\oplus}$ ) | $S_p$ ( $S_{\oplus}$ ) |
|--------------|----------|---------|---------------|--------------|-------------|------------------|------|------|-----------------------------|-----------------|------------------------|------------------------|
| 012306058-01 | OBS      | 2541.01 | 7.416763      | 137.966928   | 69.2        | 7.236            | 14.3 | 14.7 | 3.32                        | 4938            | 3.21                   | 975.56                 |
| 012306058-02 | OBS      | 2541.02 | 20.485328     | 146.925854   | 90.1        | 10.623           | 11.7 | 12.4 | 3.32                        | 4938            | 3.93                   | 251.74                 |

## Robovetter Results

| TCE          | Run Type | Disp | Score | N | S | C | E | Comments   |
|--------------|----------|------|-------|---|---|---|---|------------|
| 012306058-01 | OBS      | PC   | 0.87  | 0 | 0 | 0 | 0 | NO_COMMENT |
| 012306058-02 | OBS      | PC   | 0.99  | 0 | 0 | 0 | 0 | NO_COMMENT |

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

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

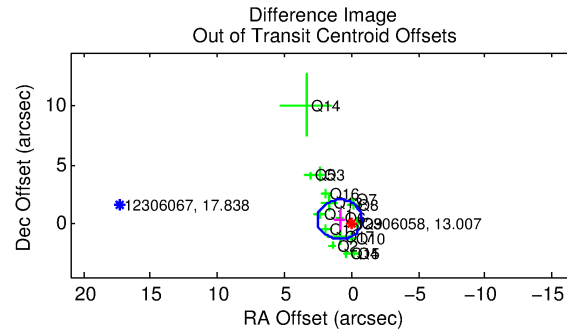
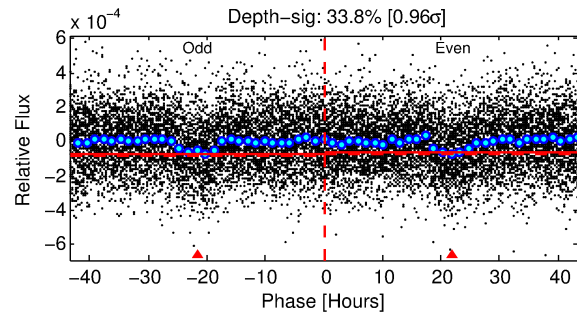
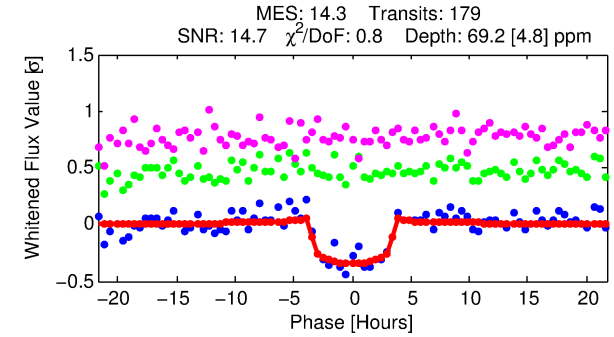
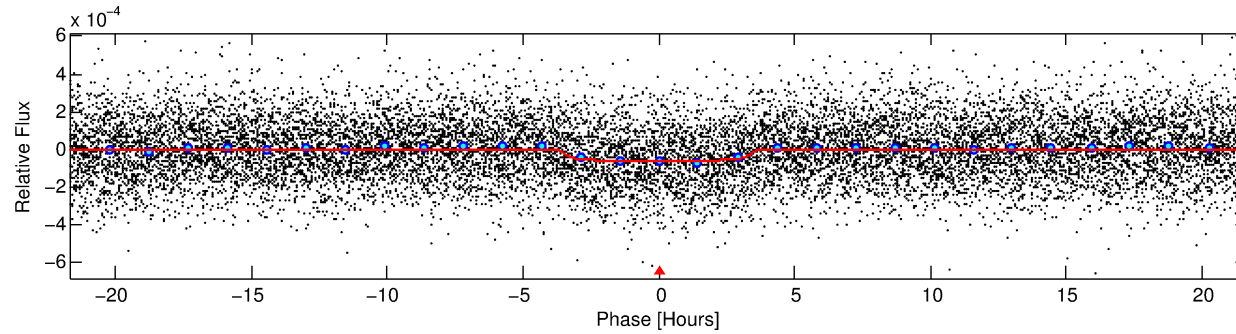
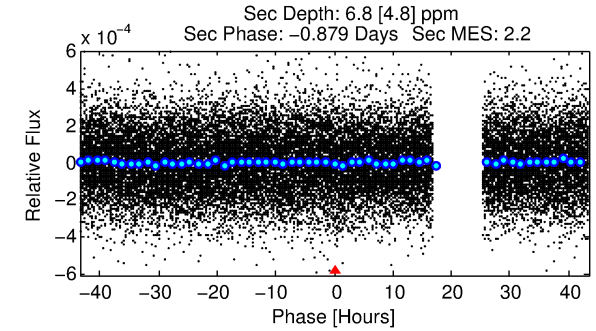
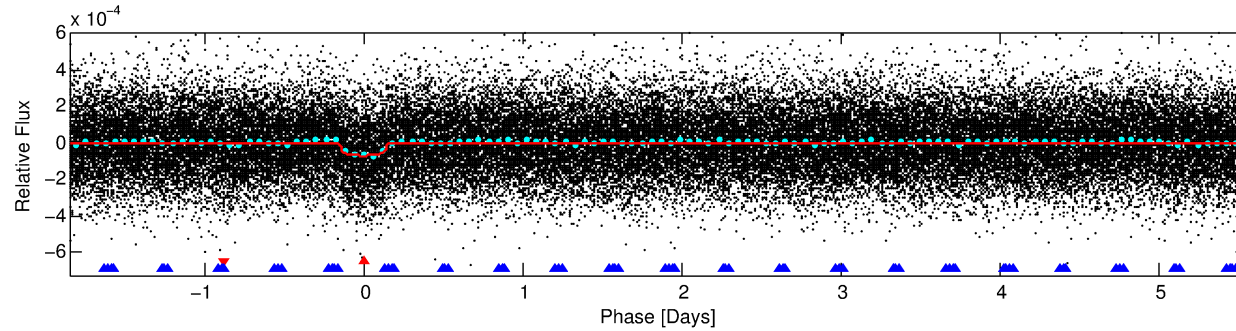
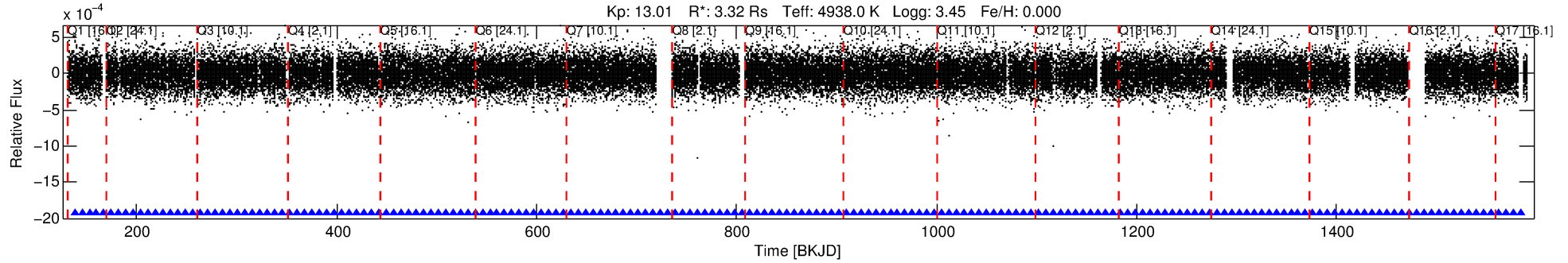
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 012306058-01

No Significant Match Found

# DV One-Page Summary

KIC: 12306058 Candidate: 1 of 2 Period: 7.417 d  
KOI: K02541.01 Name: Kepler-391b Corr: 0.990



## DV Fit Results:

Period = 7.41676 [0.00006] d  
Epoch = 137.9669 [0.0066] BKJD  
Rp/R\* = 0.0089 [0.0027]  
a/R\* = 4.34 [4.83]  
b = 0.85 [0.39]  
Seff = 975.56 [253.26]  
Teq = 1425 [92] K  
Rp = 3.21 [1.15] Re  
a = 0.0777 [0.0128] AU  
Ag = 2.20 [2.12] [0.57σ]  
Teffp = 2684 [625] K [1.99σ]

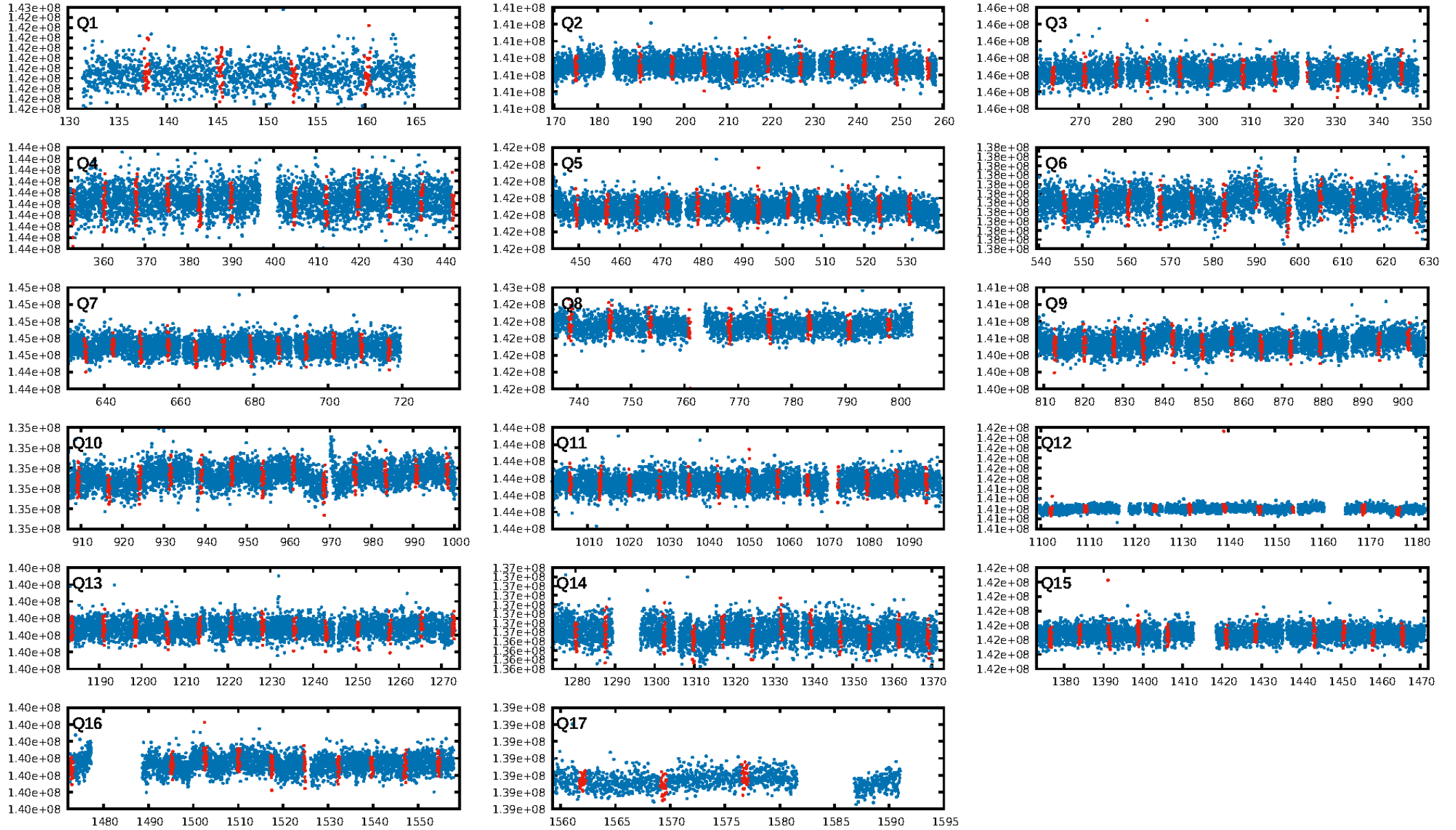
## DV Diagnostic Results:

ShortPeriod-sig: N/A  
LongPeriod-sig: 100.0% [24.40σ]  
ModelChiSquare2-sig: 100.0%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 2.82e-41  
RollingBand-fgt: 1.00 [172/172]  
GhostDiagnostic-chr: 9.368  
Centroid-sig: 29.4%  
Centroid-so: 0.856 arcsec [1.30σ]  
OotOffset-rm: 0.941 arcsec [1.69σ]  
OotOffset-st: 4/4/4/4 [16]  
KicOffset-rm: 1.117 arcsec [1.87σ]  
KicOffset-st: 4/4/4/4 [16]  
DiffImageQuality-fgm: 0.62 [10/16]  
DiffImageOverlap-fno: 1.00 [17/17]

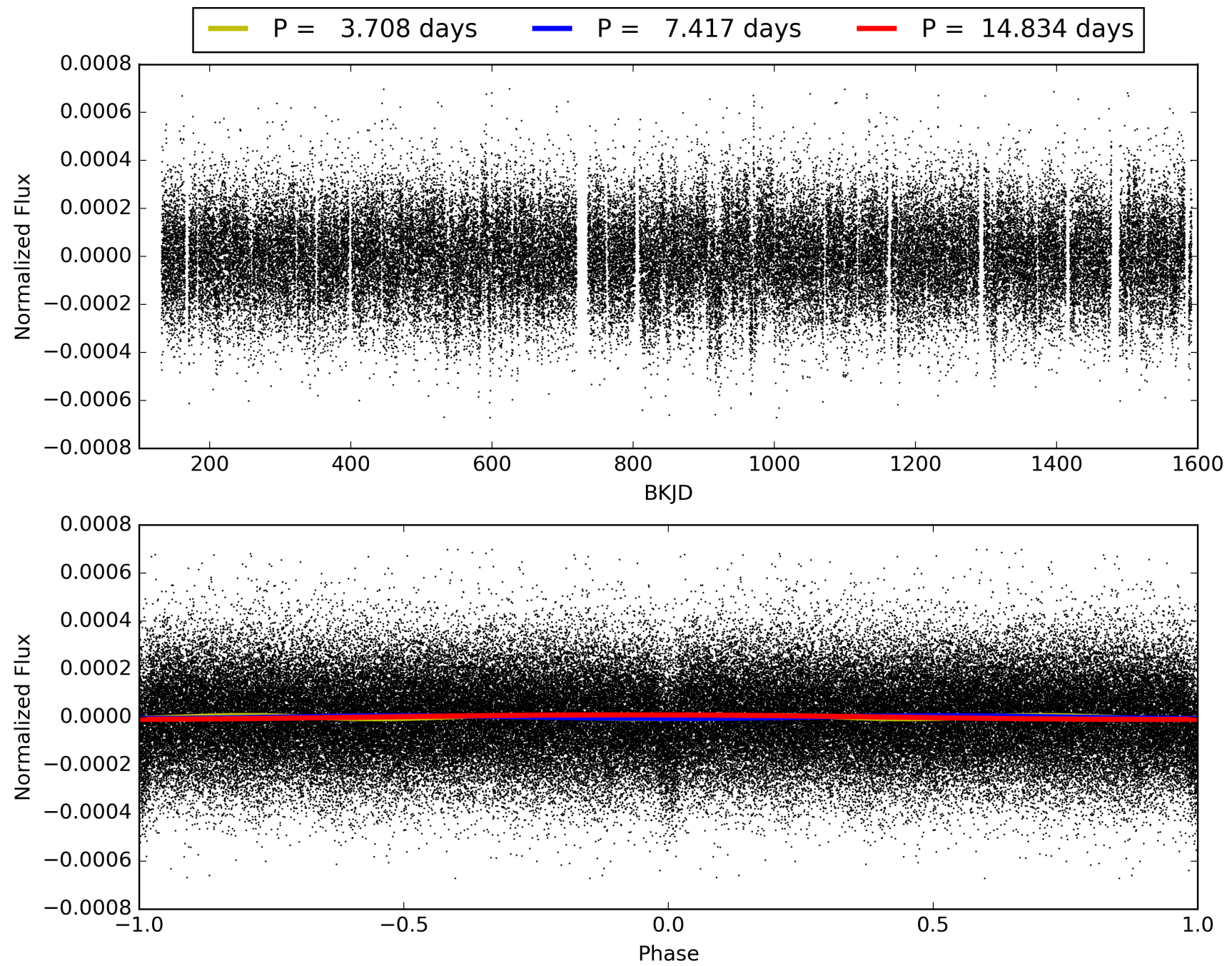
Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 28-Jan-2016 23:19:09 Z

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

# TCE 012306058-01, PDC Light Curves

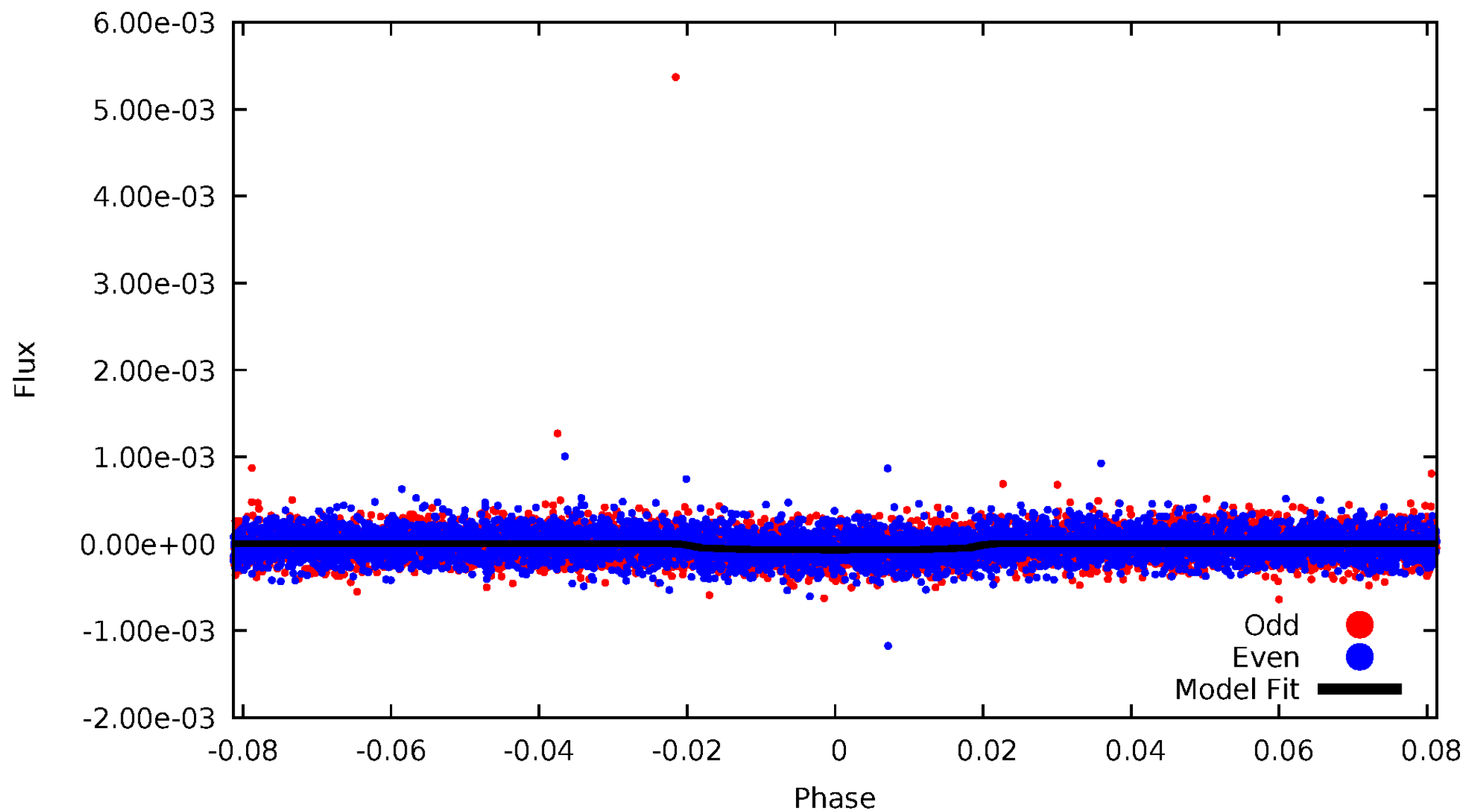


# TCE 012306058-01



# DV Odd/Even

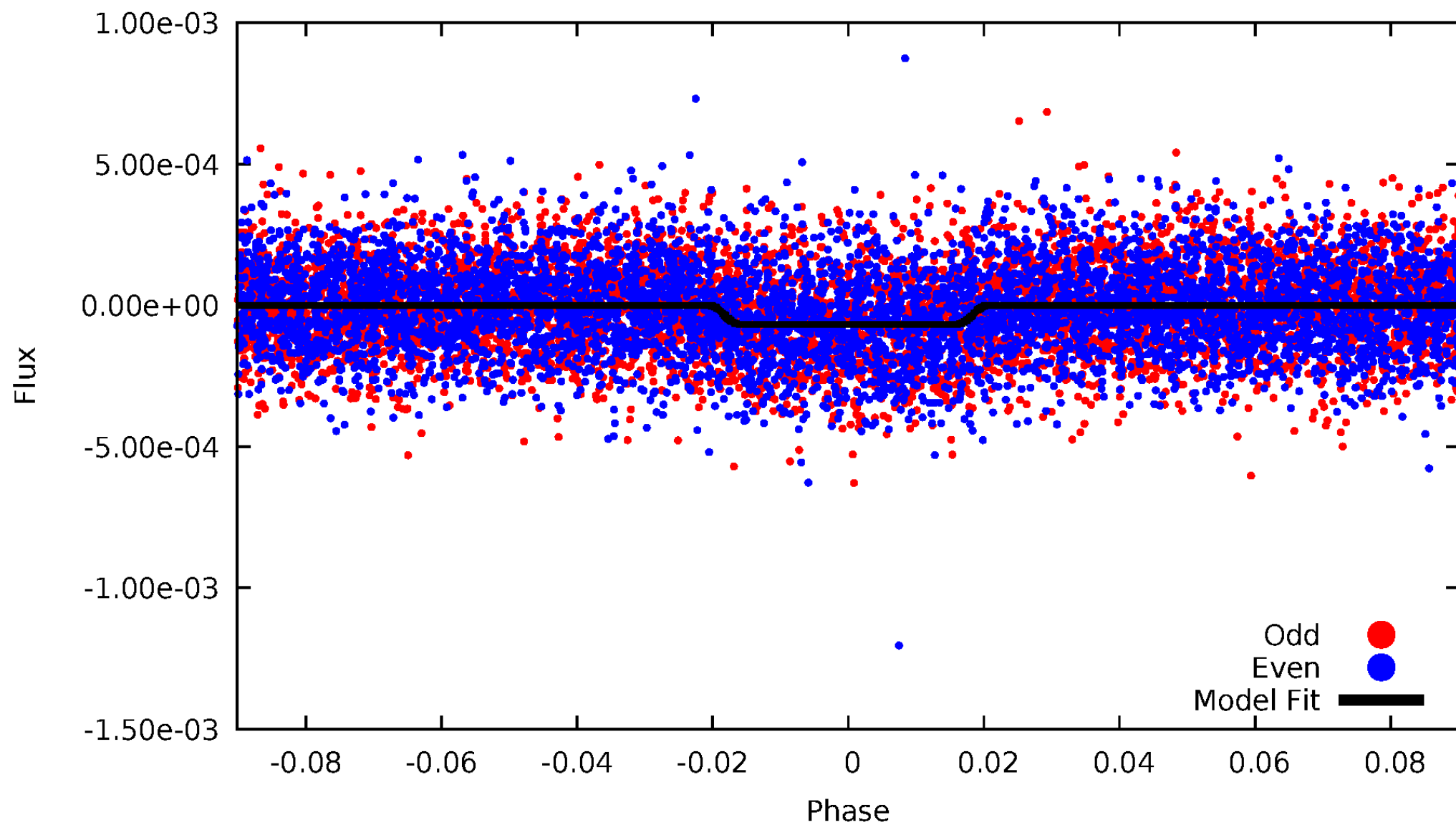
TCE 012306058-01





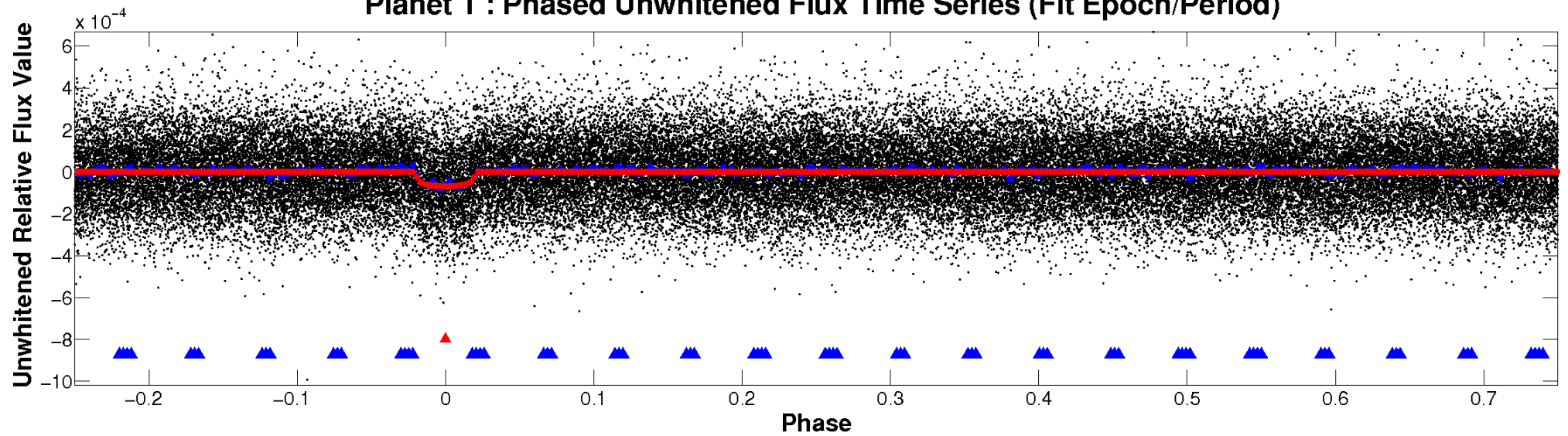
# ALT Odd/Even

TCE 012306058-01

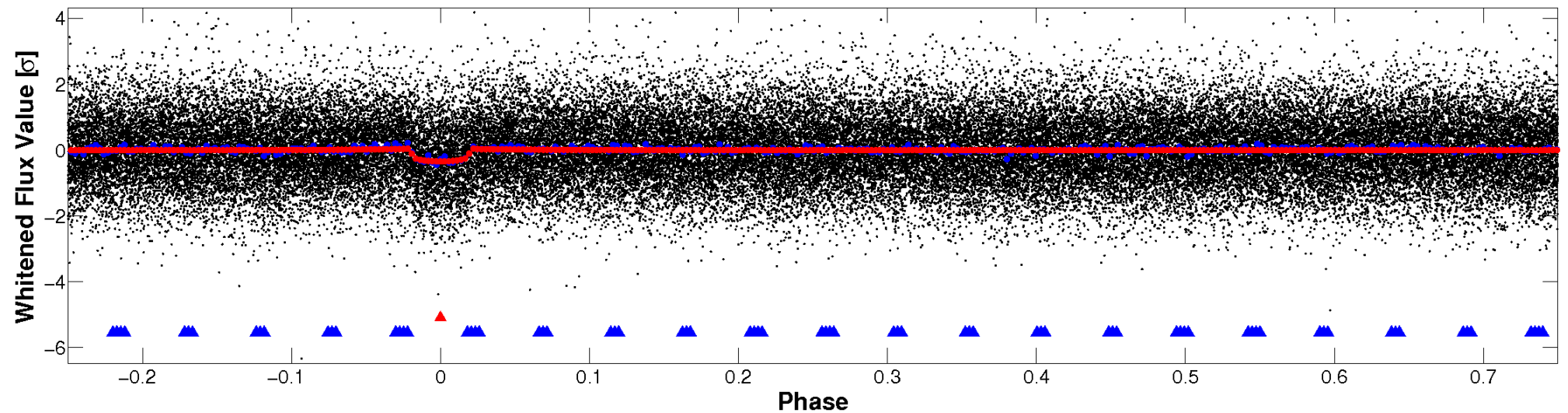


# Non-Whitened Vs. Whitened Light Curve

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

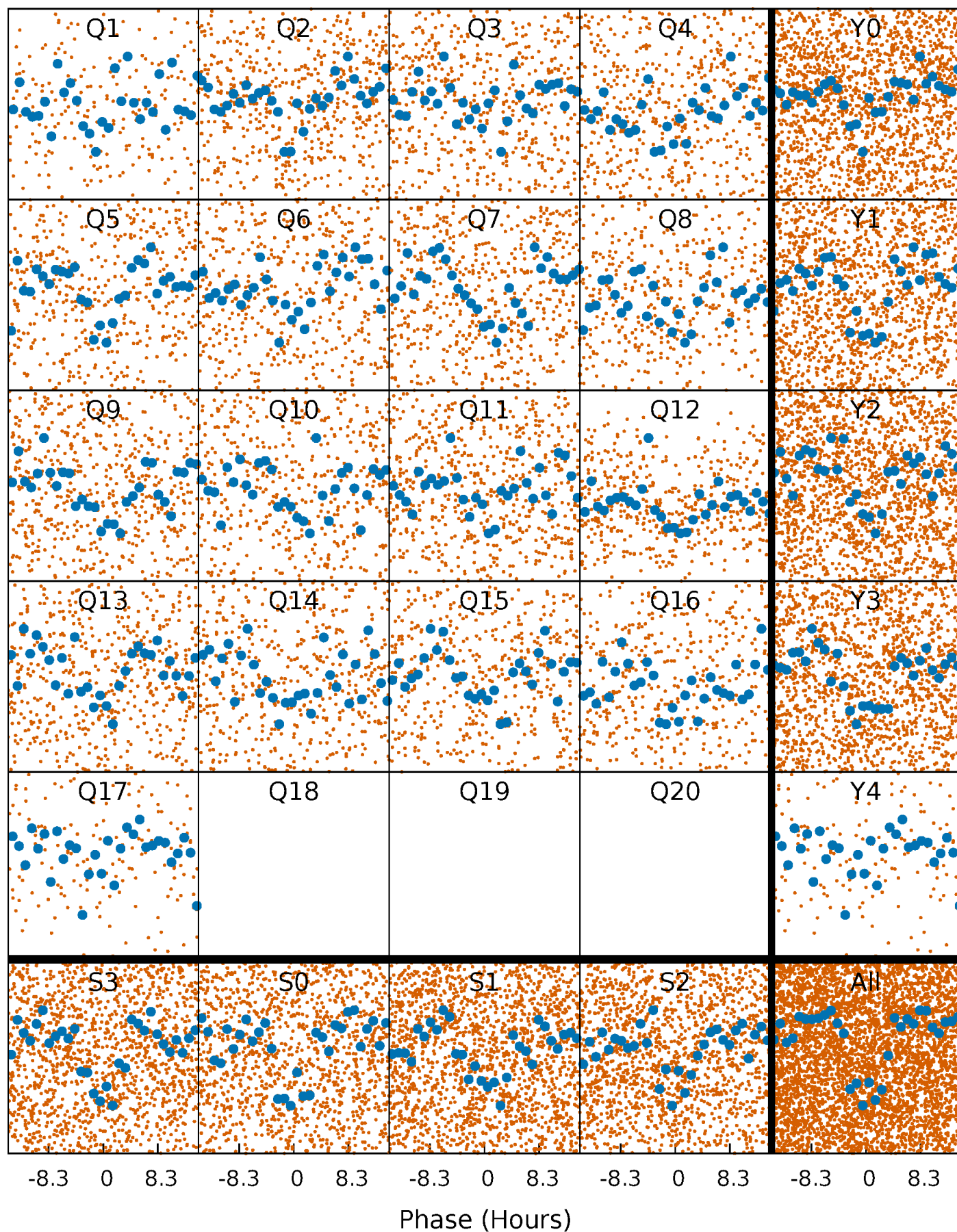


Planet 1 : Phased Whitened Flux Time Series (Fit Epoch/Period)



## PDC Quarter-Phased Transit Curves

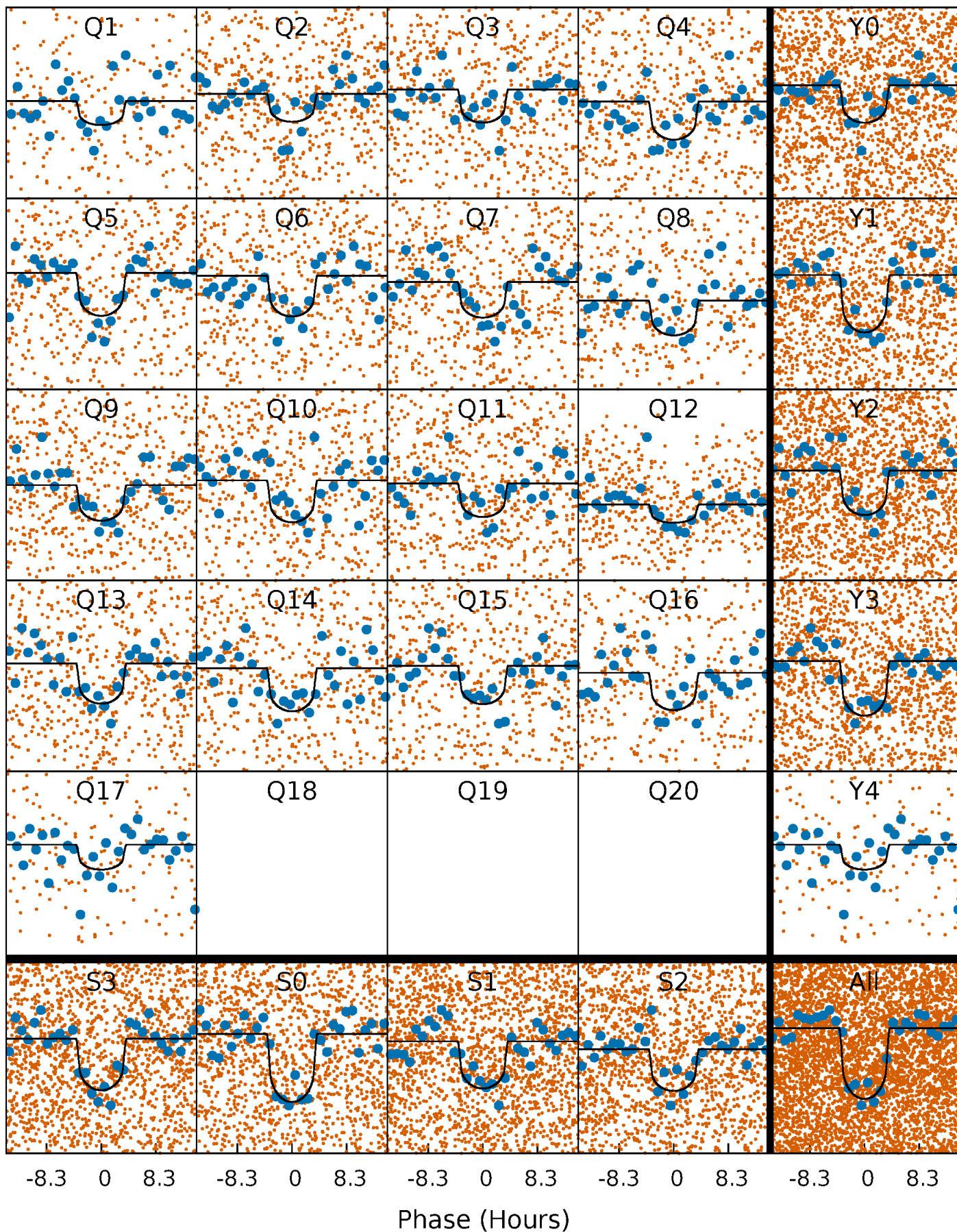
TCE 012306058-01    P= 7.416763 Days     $T_0=137.966928$  (BKJD)





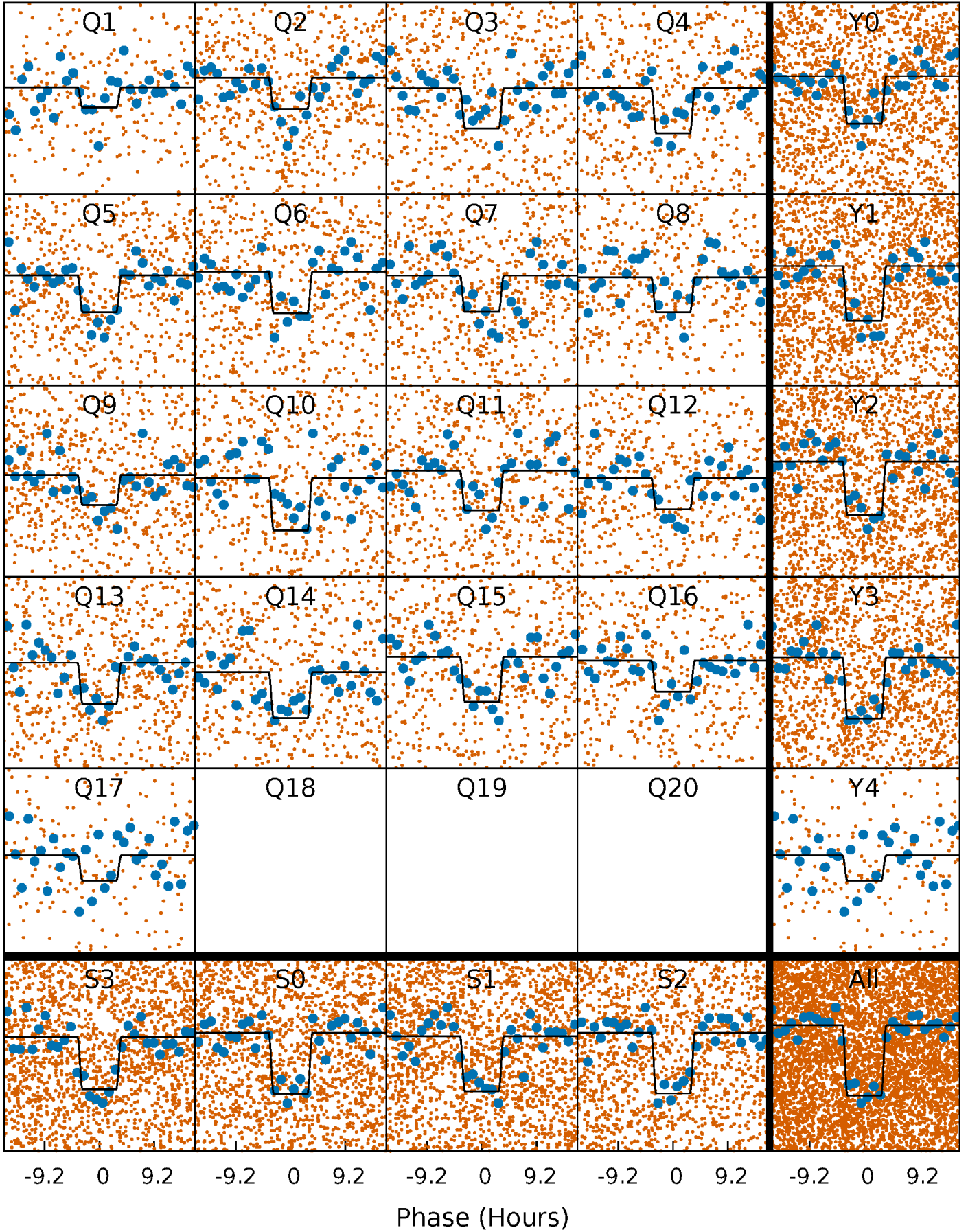
# DV Quarter-Phased Transit Curves

TCE 012306058-01 P= 7.416763 Days  $T_0=137.966928$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

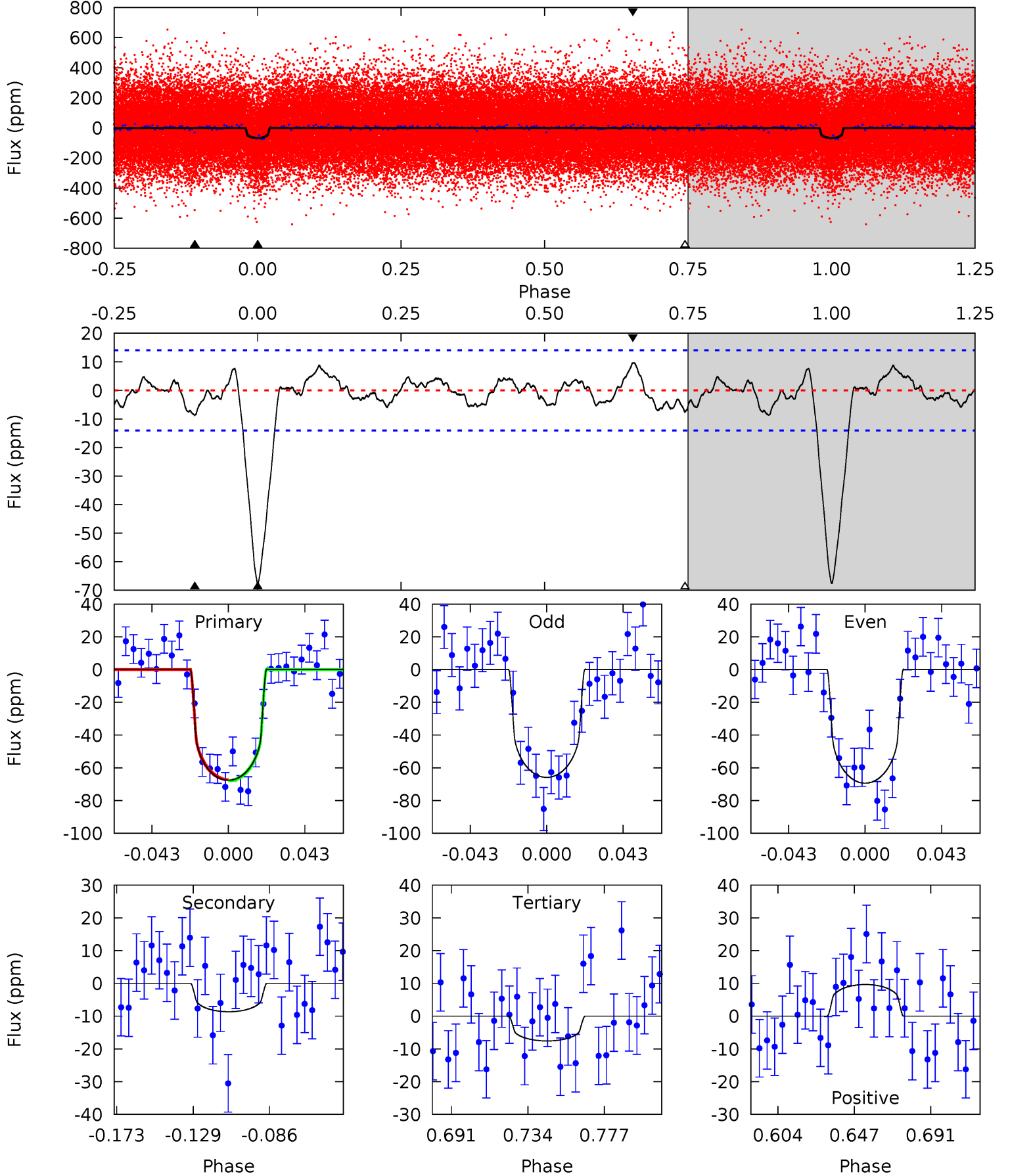
TCE 012306058-01 P= 7.416966 Days  $T_0=137.947770$  (BKJD)



# DV Model-Shift Uniqueness Test

012306058-01, P = 7.416763 Days, E = 130.550165 Days

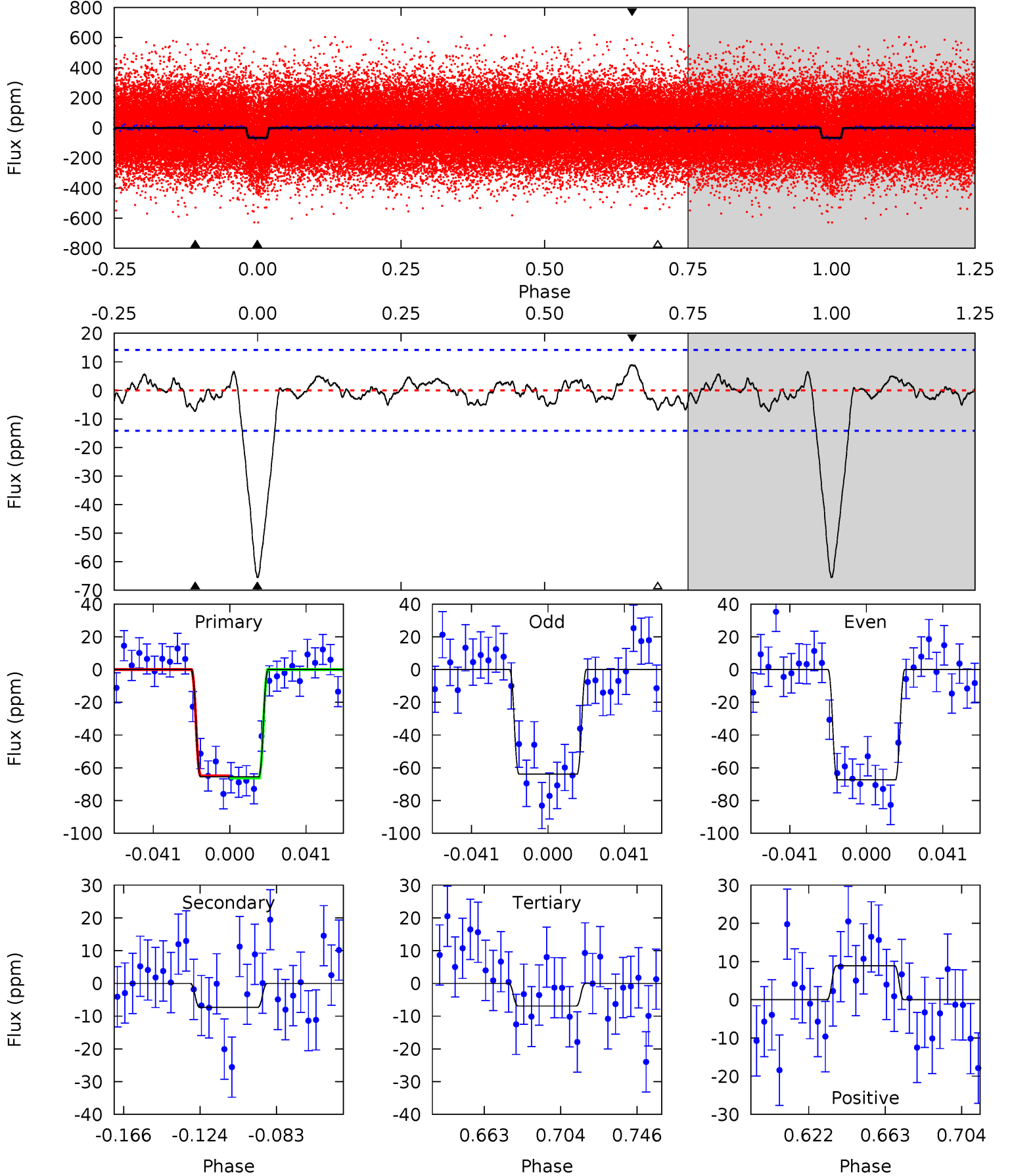
| Pri  | Sec  | Ter  | Pos  | FA <sub>1</sub> | FA <sub>2</sub> | F <sub>Red</sub> | Pri-Ter | Pri-Pos | Sec-Ter | Sec-Pos | Odd-Evn | DMM  | Shape | TAT  |
|------|------|------|------|-----------------|-----------------|------------------|---------|---------|---------|---------|---------|------|-------|------|
| 22.8 | 2.92 | 2.55 | 3.26 | 4.74            | 2.02            | 1.24             | 20.2    | 19.5    | 0.37    | -0.33   | 0.60    | 0.97 | 0.12  | 0.11 |



# Alt Model-Shift Uniqueness Test

012306058-01, P = 7.416966 Days, E = 130.530804 Days

| Pri  | Sec  | Ter  | Pos  | FA <sub>1</sub> | FA <sub>2</sub> | F <sub>Red</sub> | Pri-Ter | Pri-Pos | Sec-Ter | Sec-Pos | Odd-Evn | DMM  | Shape | TAT  |
|------|------|------|------|-----------------|-----------------|------------------|---------|---------|---------|---------|---------|------|-------|------|
| 22.0 | 2.46 | 2.32 | 2.99 | 4.75            | 2.04            | 1.02             | 19.7    | 19.0    | 0.14    | -0.53   | 0.58    | 0.95 | 0.12  | 0.22 |





### Stellar Parameters For KIC 012306058

|        | $T_{\text{eff}}(K)$ | $\log(g)$                 | [Fe/H]                    | $R (R_{\odot})$           | $M(M_{\odot})$            | $p_{\star} (\text{g}\cdot\text{cm}^{-3})$ |
|--------|---------------------|---------------------------|---------------------------|---------------------------|---------------------------|---|
|        | $4938^{+69}_{-79}$  | $3.450^{+0.143}_{-0.130}$ | $0.000^{+0.150}_{-0.150}$ | $3.324^{+0.613}_{-0.551}$ | $1.136^{+0.170}_{-0.153}$ | $0.044^{+0.030}_{-0.017}$                 |
|        | +1%/-2%             | +4%/-4%                   | +inf%/-inf%               | +18%/-17%                 | +15%/-13%                 | +69%/-38%                                 |
| Source | SPE58               | SPE58                     | SPE58                     | DSEP                      |                           |   |

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

### Secondary Eclipse Parameters for KIC 012306058-01 / KOI 2541.01

| Detrend | Depth (ppm) | $R_p (R_{\oplus})$     | $T_{\text{max}} (K)$ | $T_{\text{obs}} (K)$ | $A_{\text{obs}}$          |
|---------|-------------|------------------------|----------------------|----------------------|---------------------------|
| DV      | $-9 \pm 3$  | $3.22^{+1.14}_{-1.01}$ | $1989^{+99}_{-97}$   | $3257^{+478}_{-341}$ | $2.690^{+3.363}_{-1.315}$ |
| Alt.    | $-7 \pm 3$  | $2.98^{+1.08}_{-1.04}$ | $1990^{+93}_{-97}$   | $3243^{+546}_{-417}$ | $2.586^{+4.275}_{-1.418}$ |

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

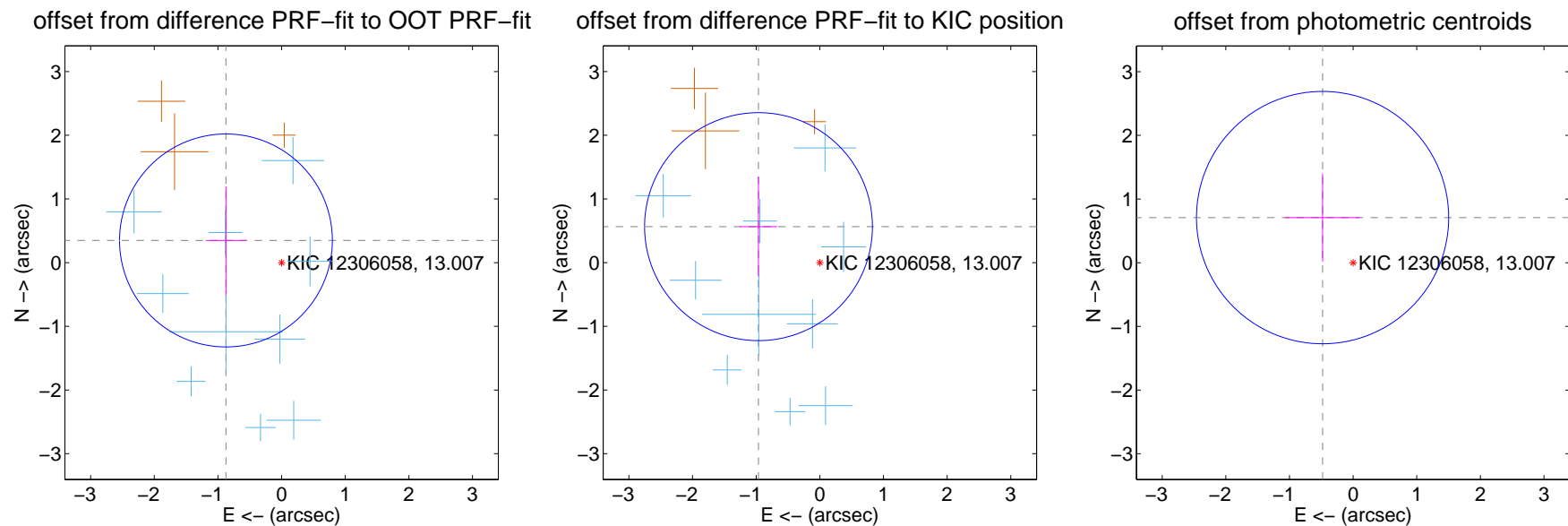
## DV Centroid Data

Supplemental centroid analysis for 012306058-01. Kepler magnitude: 13.01. Transit SNR 14.71

There are 10 quarters with good PRF difference image offsets

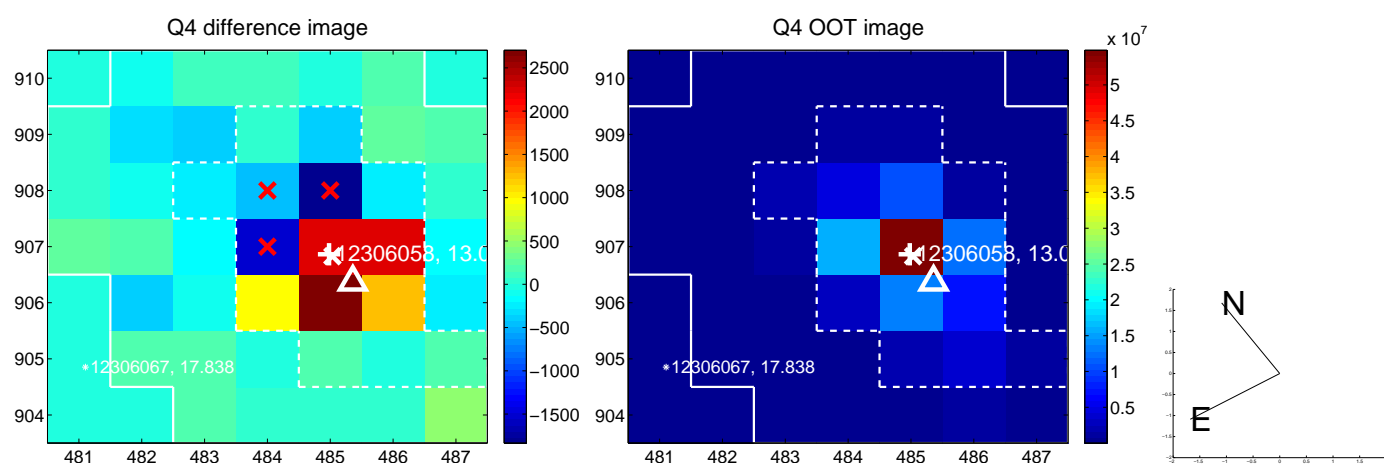
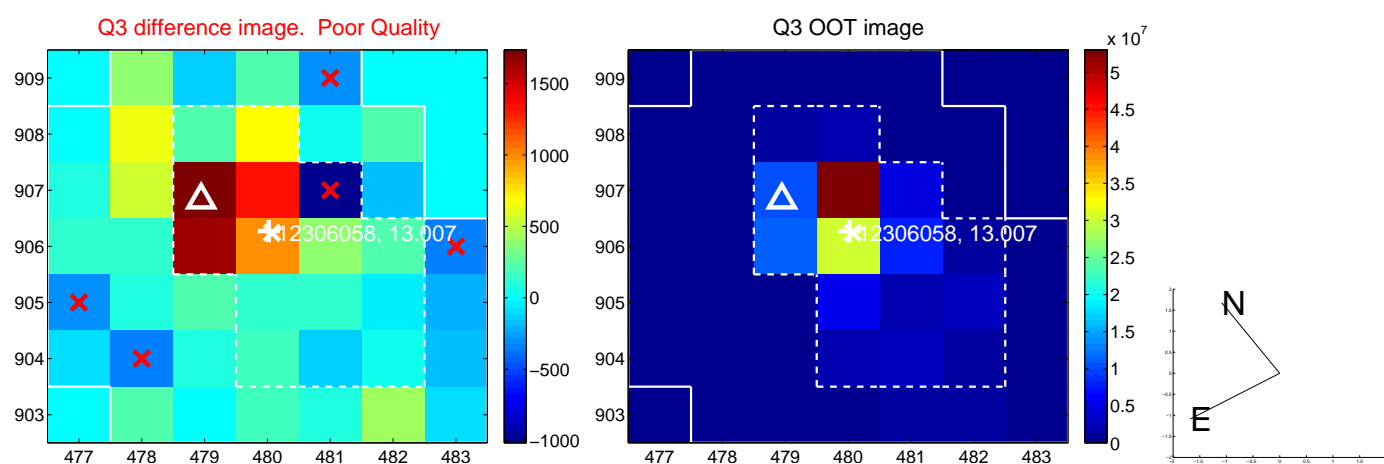
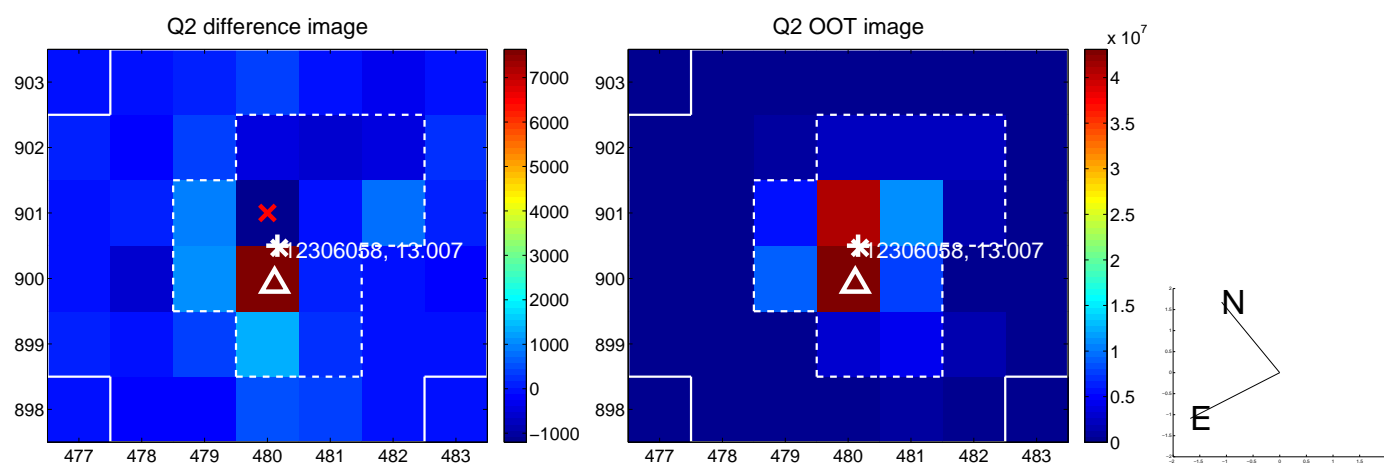
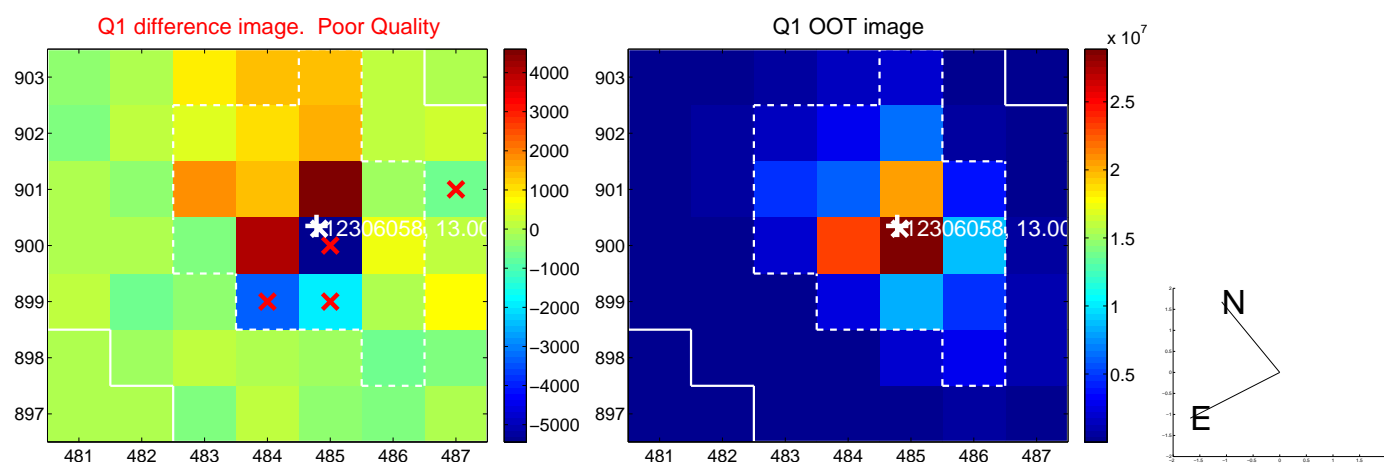
The direct PRF centroid is offset from the target star catalog position by about 0.29 arcsec

|   | Distance in arcsec | Distance / $\sigma$ | $\Delta$ RA       | $\Delta$ Dec      |
|---|--------------------|---------------------|-------------------|-------------------|
| PRF-fit source offset from OOT          | $0.941 \pm 0.557$  | 1.69                | $0.874 \pm 0.315$ | $0.348 \pm 0.850$ |
| PRF-fit source offset from KIC position | $1.117 \pm 0.597$  | 1.87                | $0.964 \pm 0.292$ | $0.565 \pm 0.782$ |
| photometric centroid source offset      | $0.86 \pm 0.66$    | 1.30                | $0.48 \pm 0.59$   | $0.71 \pm 0.69$   |

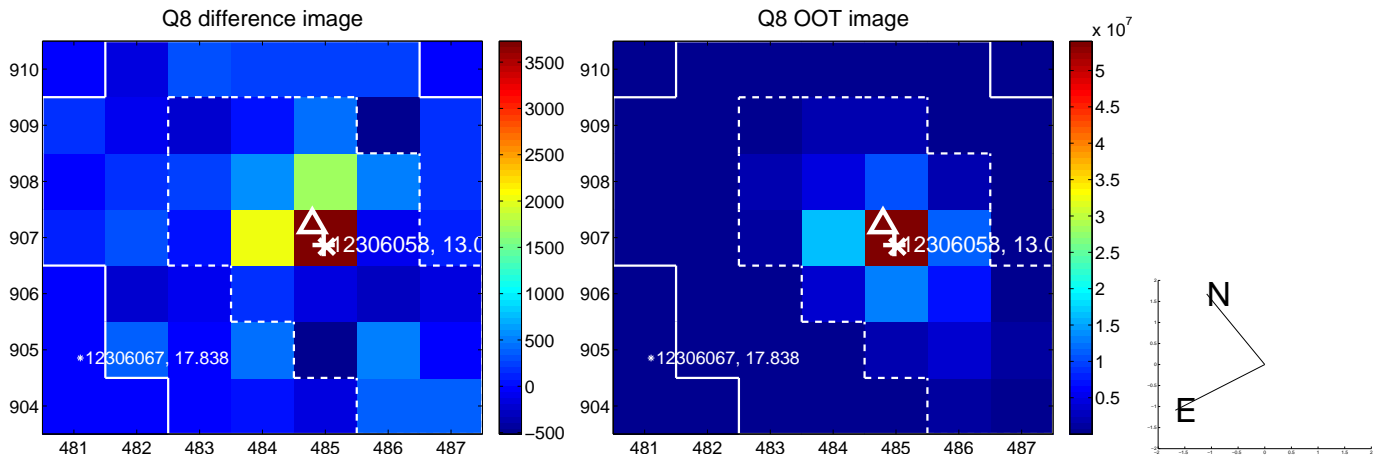
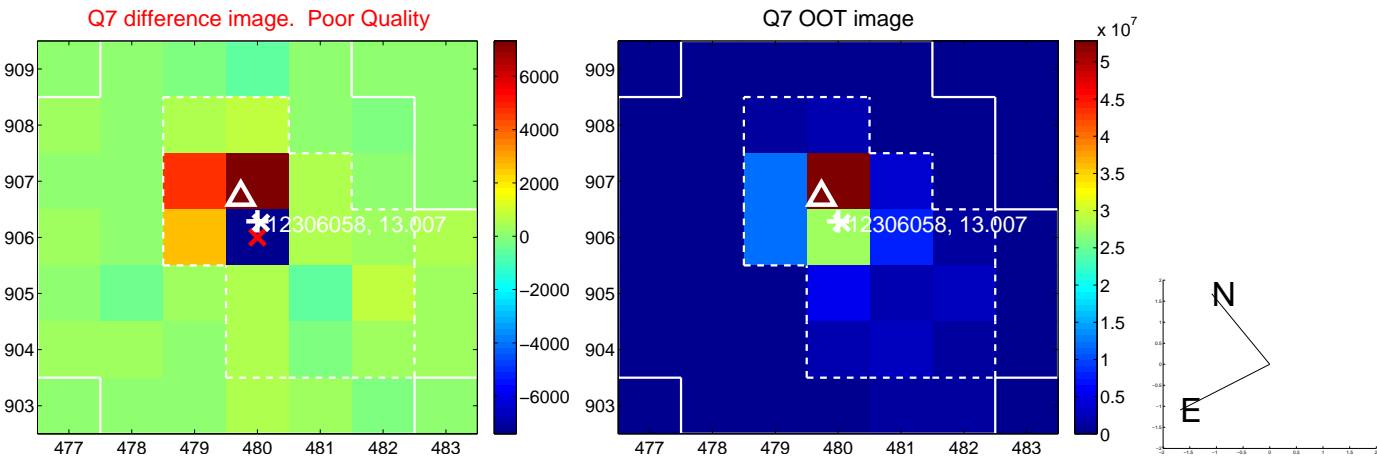
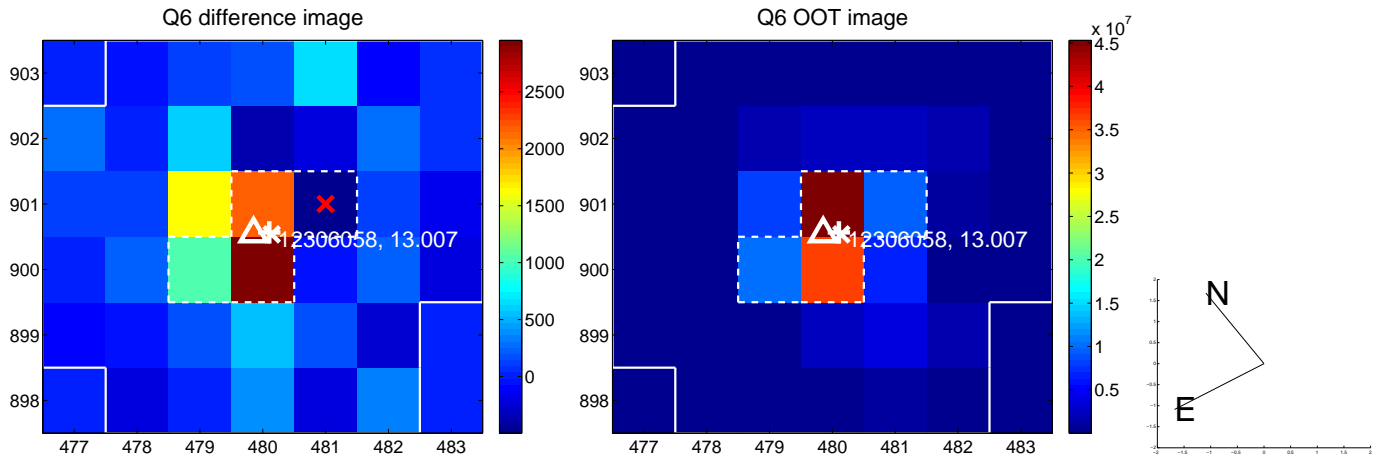
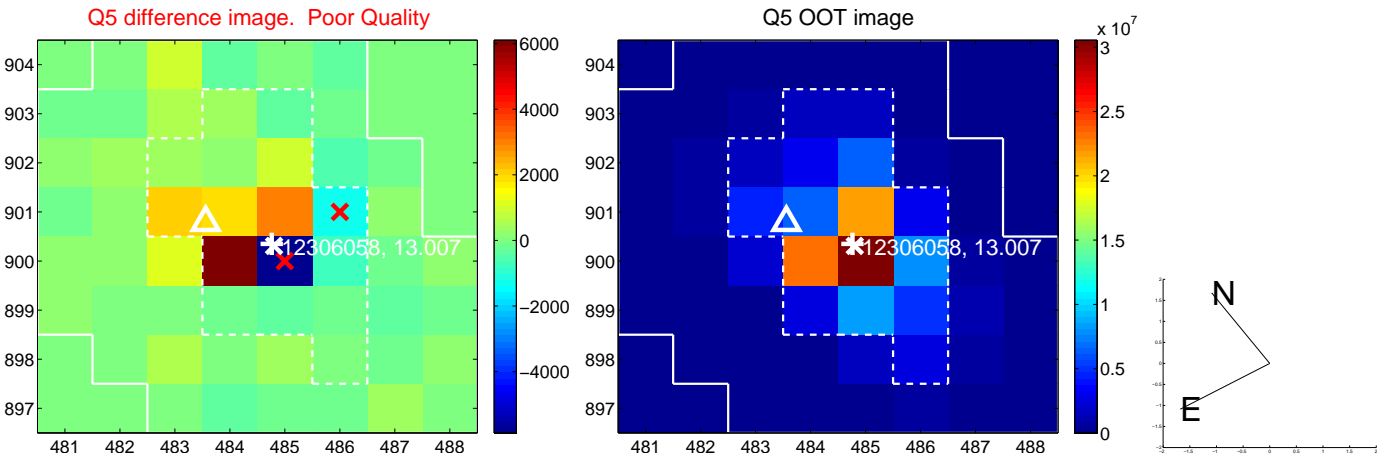


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets**; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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

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

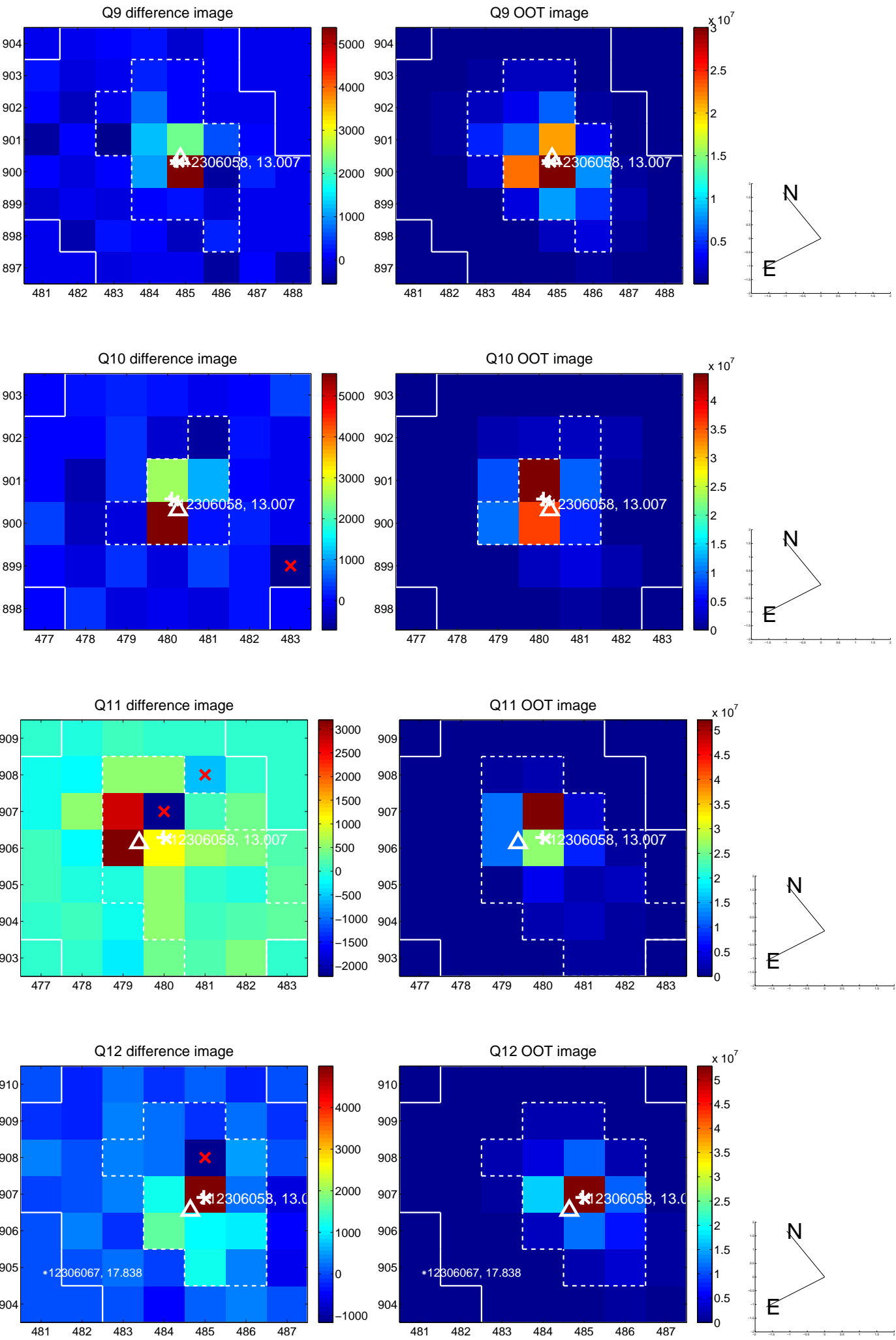


white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

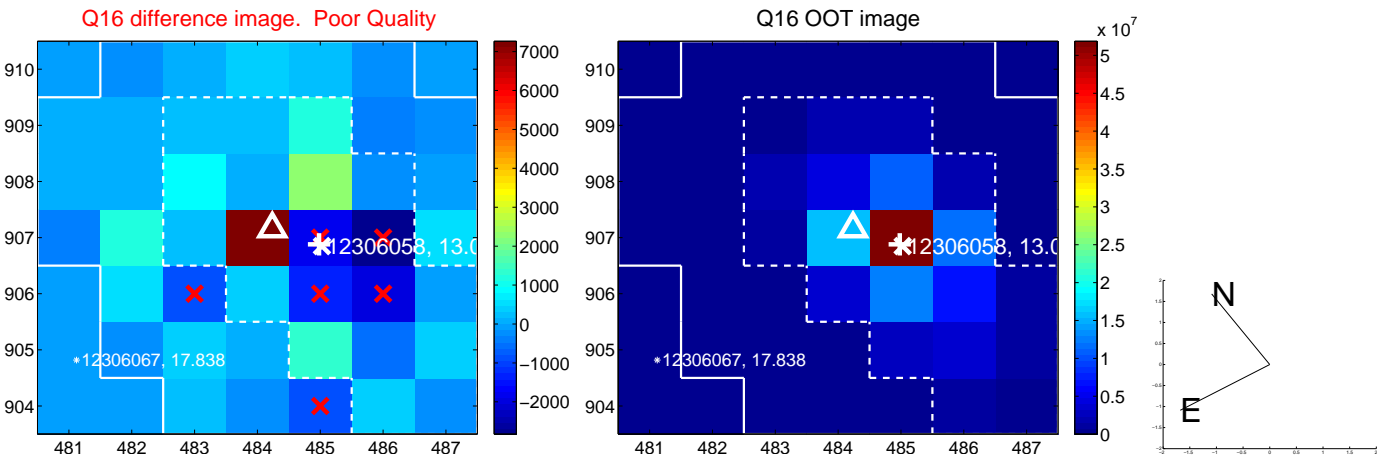
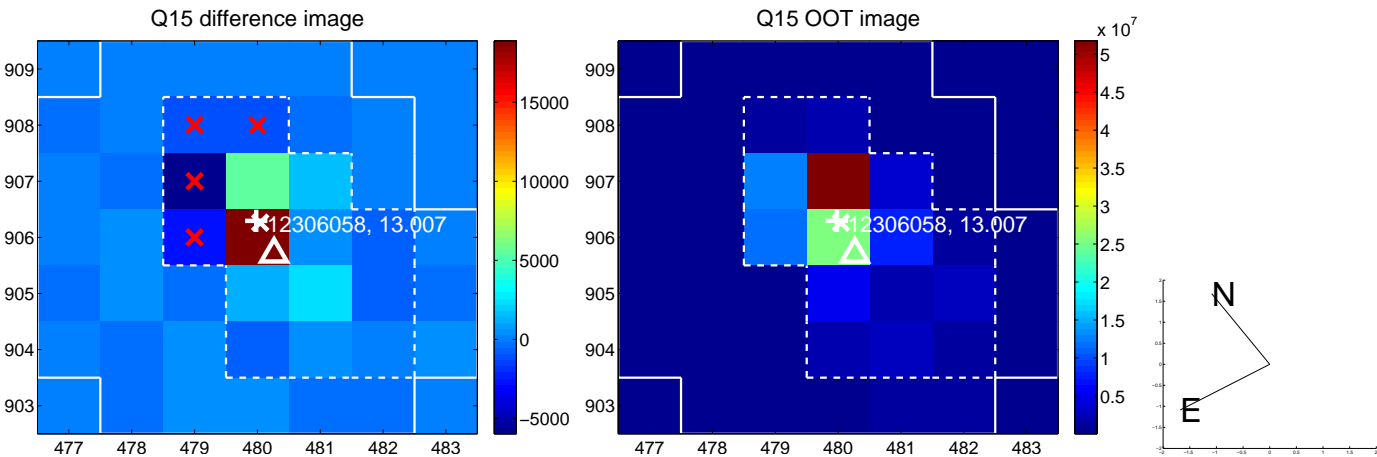
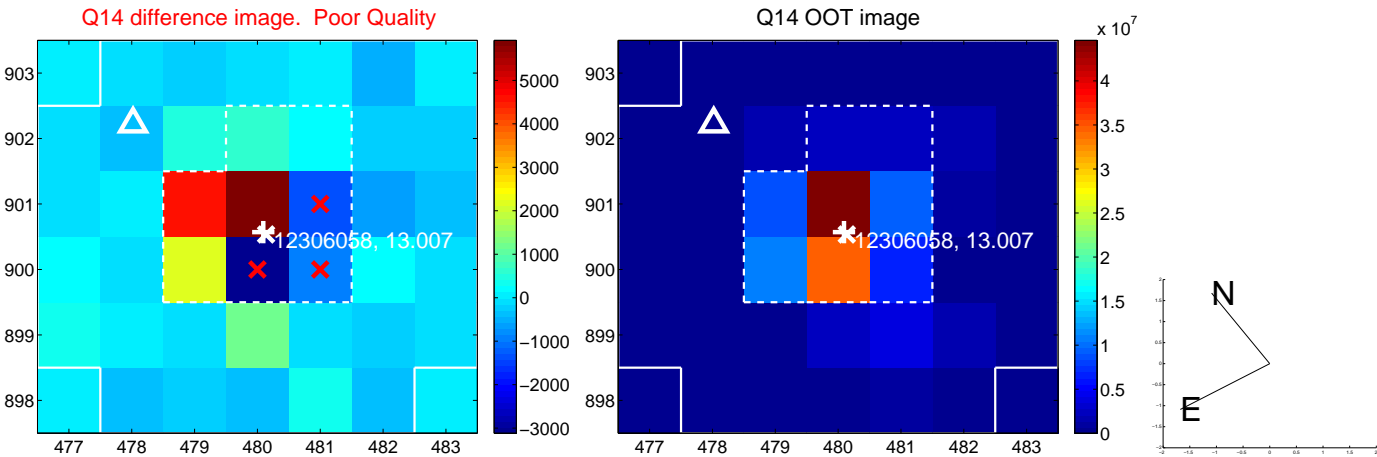
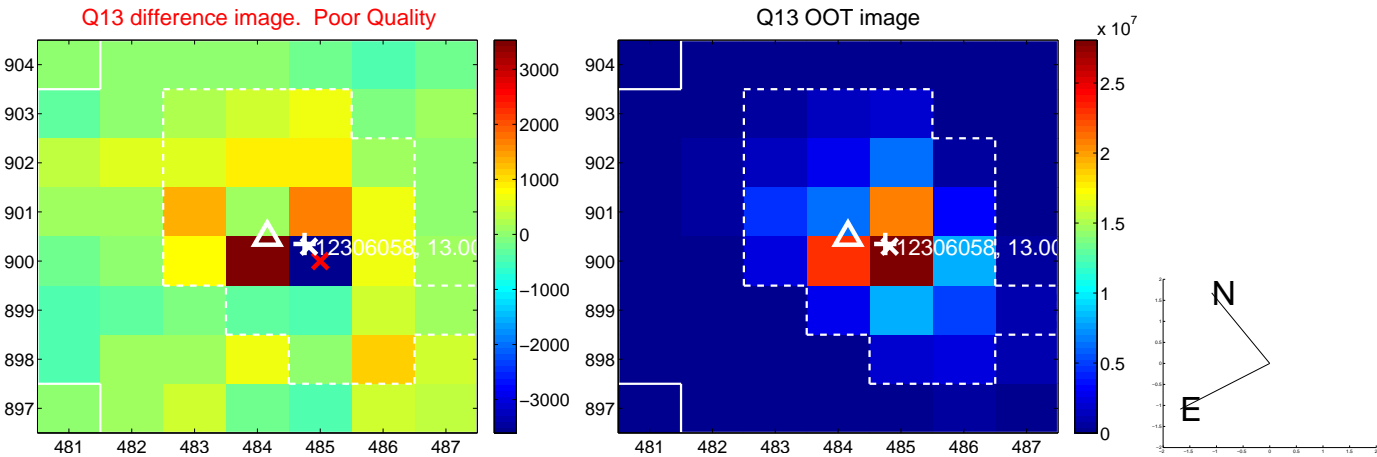




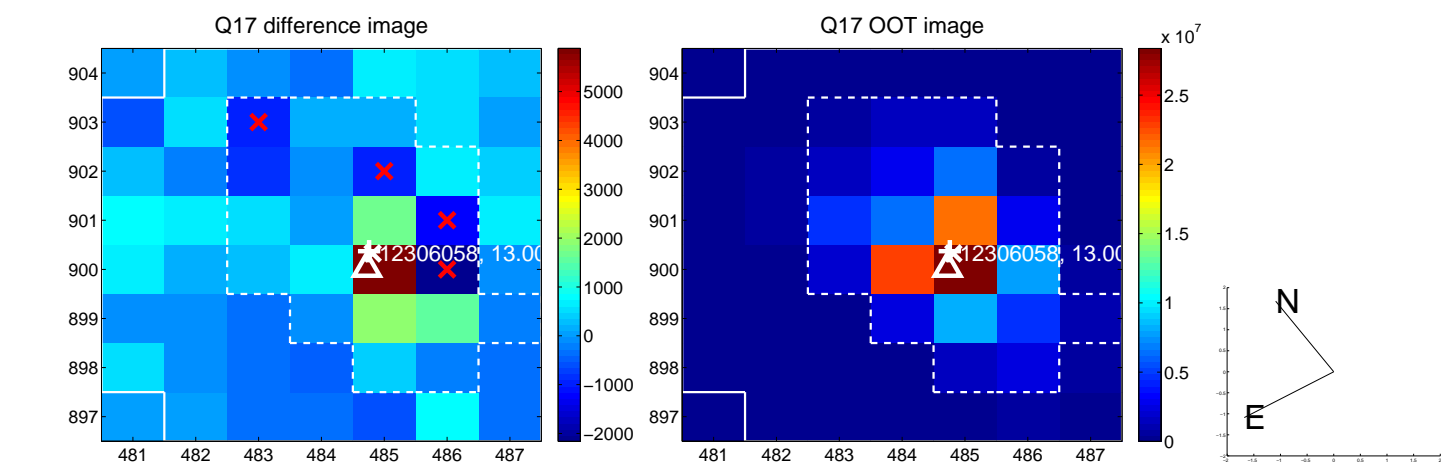
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



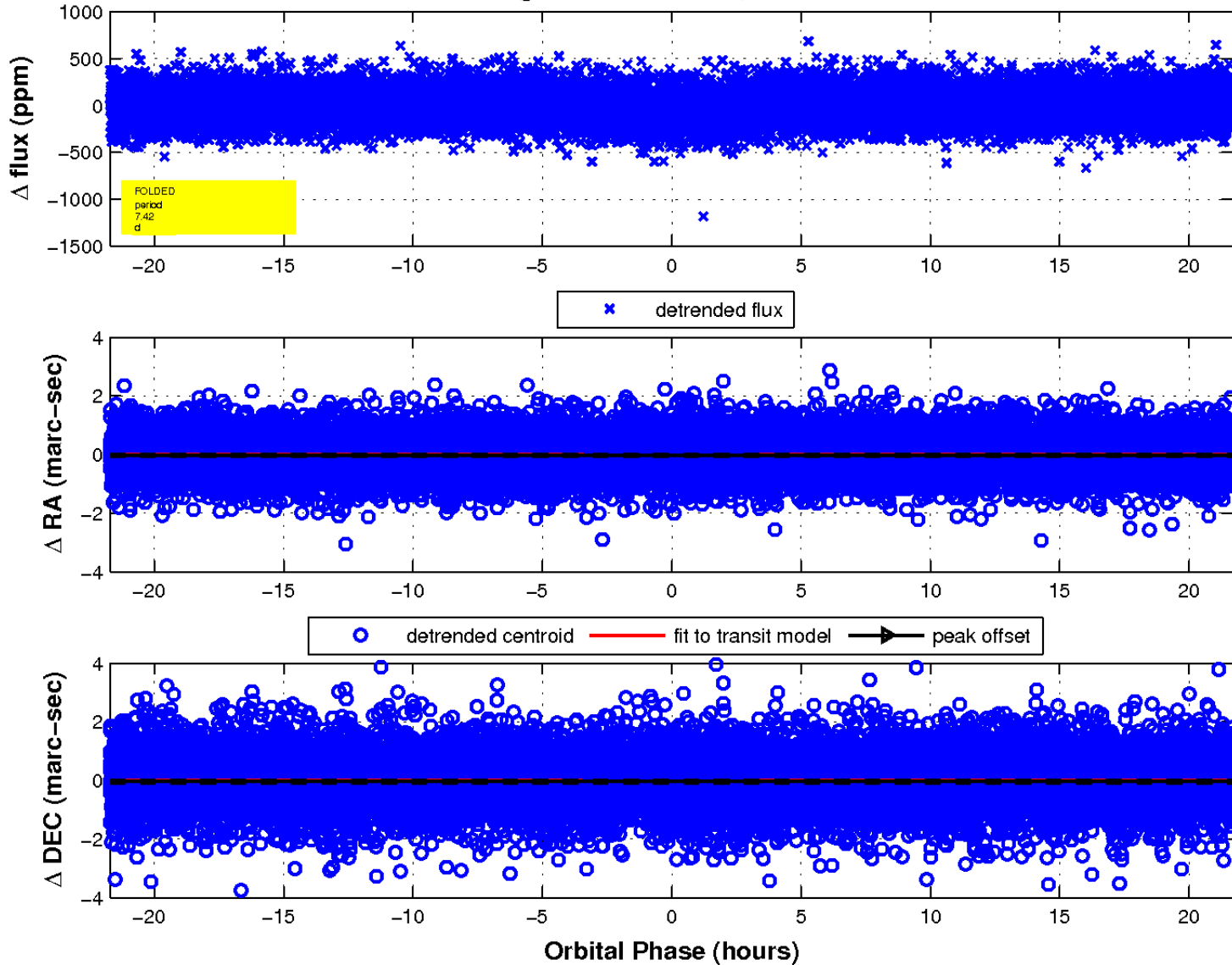
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

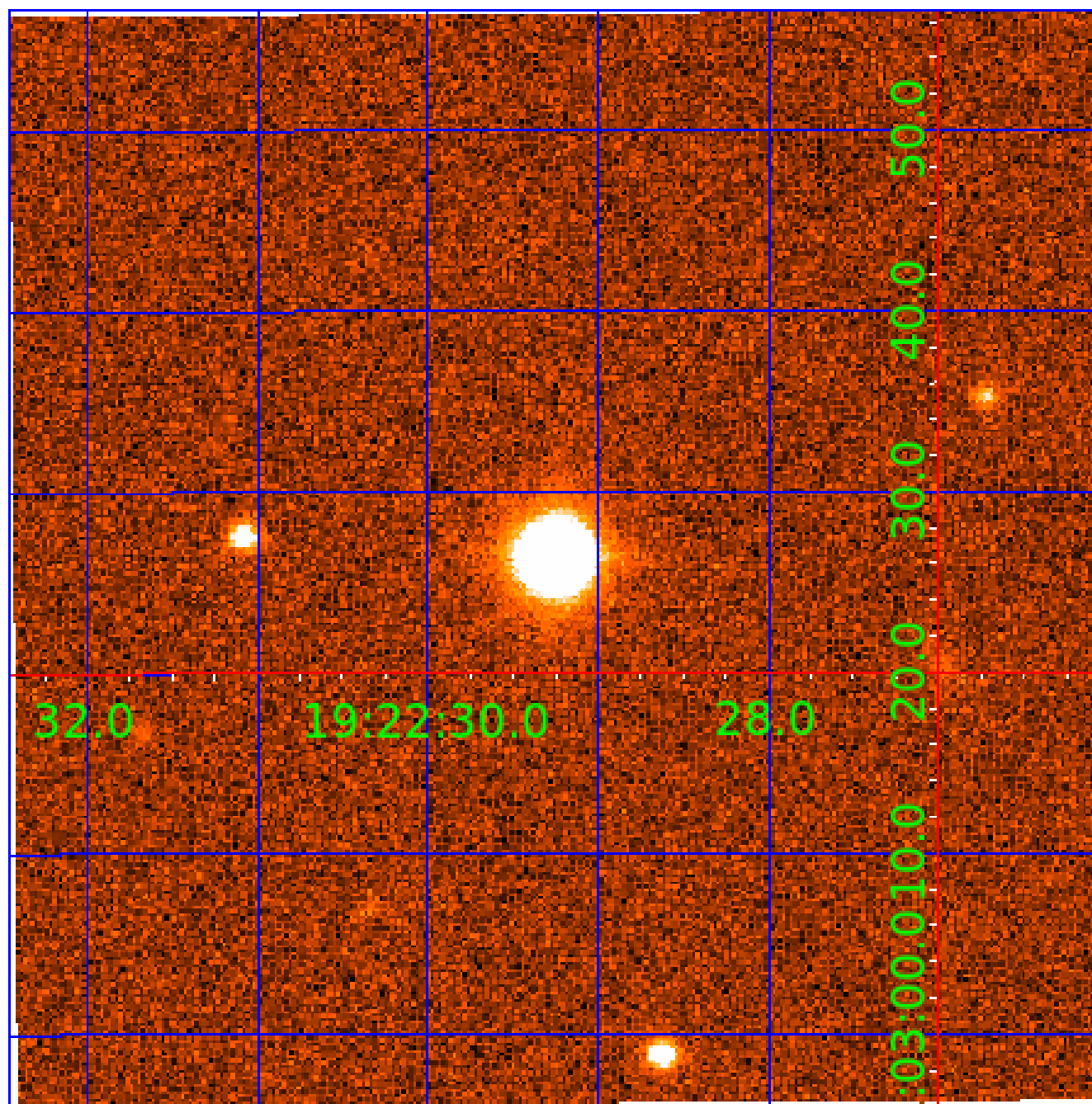


fluxWeightedCentroids, Planet 1 of 2



UKIRT Image

Declination





# KIC 012306058

## 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) | $R_p$ ( $R_{\oplus}$ ) | $S_p$ ( $S_{\oplus}$ ) |
|--------------|----------|---------|---------------|--------------|-------------|------------------|------|------|-----------------------------|-----------------|------------------------|------------------------|
| 012306058-01 | OBS      | 2541.01 | 7.416763      | 137.966928   | 69.2        | 7.236            | 14.3 | 14.7 | 3.32                        | 4938            | 3.21                   | 975.56                 |
| 012306058-02 | OBS      | 2541.02 | 20.485328     | 146.925854   | 90.1        | 10.623           | 11.7 | 12.4 | 3.32                        | 4938            | 3.93                   | 251.74                 |

## Robovetter Results

| TCE          | Run Type | Disp | Score | N | S | C | E | Comments   |
|--------------|----------|------|-------|---|---|---|---|------------|
| 012306058-01 | OBS      | PC   | 0.87  | 0 | 0 | 0 | 0 | NO_COMMENT |
| 012306058-02 | OBS      | PC   | 0.99  | 0 | 0 | 0 | 0 | NO_COMMENT |

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

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

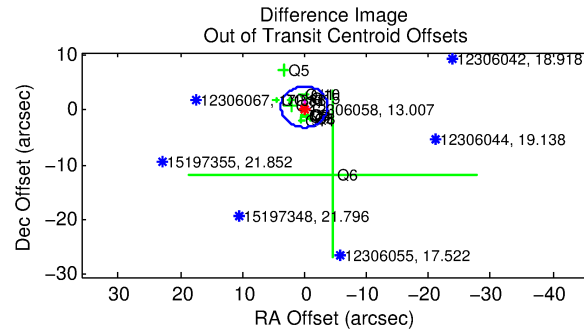
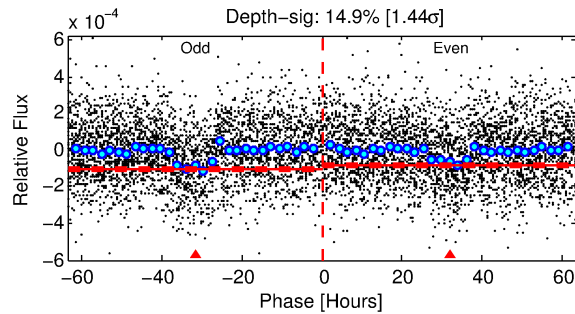
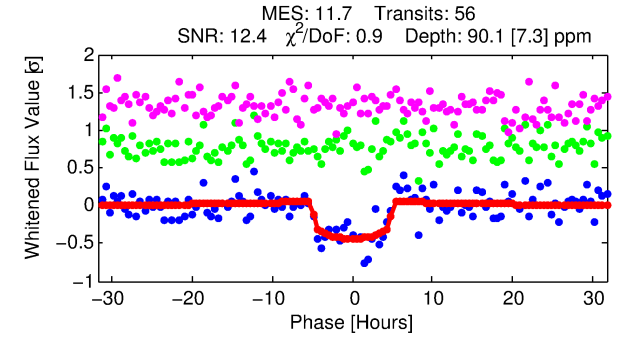
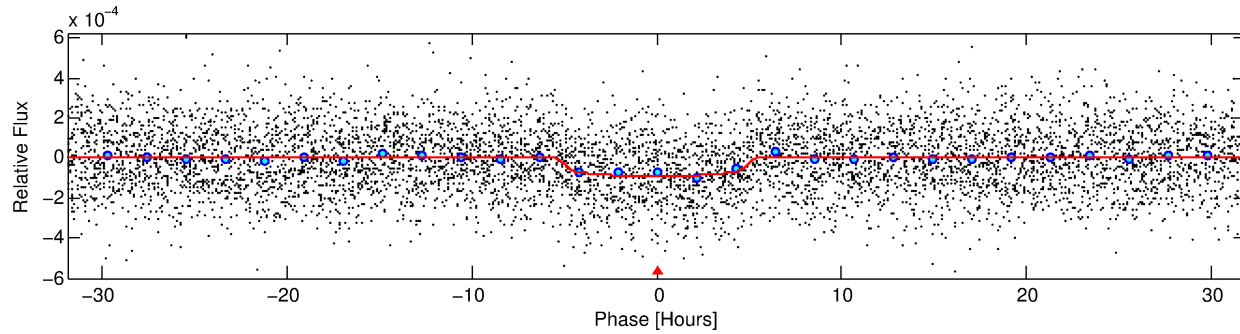
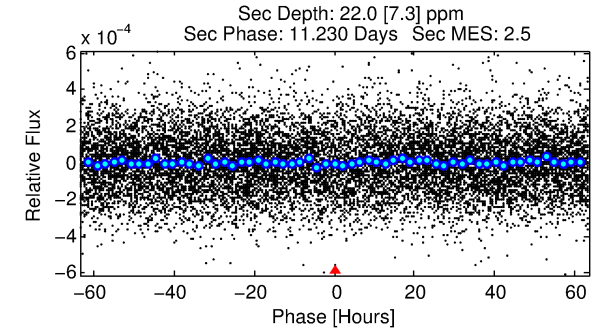
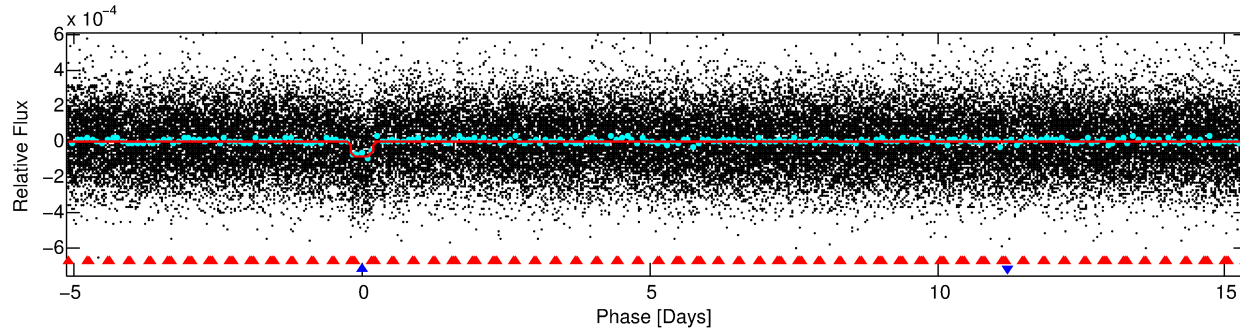
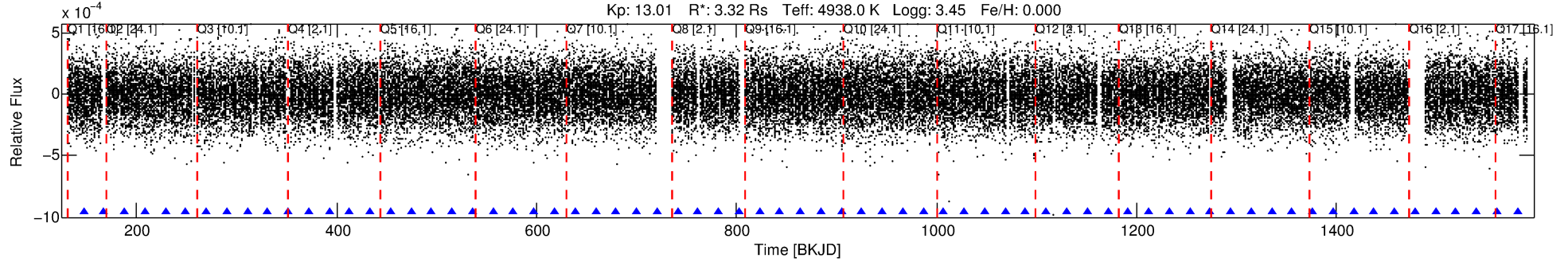
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 012306058-02

No Significant Match Found

# DV One-Page Summary

KIC: 12306058 Candidate: 2 of 2 Period: 20.485 d  
KOI: K02541.02 Name: Kepler-391c Corr: 0.972



## DV Fit Results:

Period = 20.48533 [0.00033] d  
Epoch = 146.9259 [0.0132] BKJD  
Rp/R\* = 0.0108 [0.0015]  
a/R\* = 6.32 [3.47]  
b = 0.92 [0.10]  
Seff = 251.74 [65.35]  
Teff = 1016 [66] K  
Rp = 3.93 [0.91] Re  
a = 0.1529 [0.0252] AU  
Ag = 18.32 [9.22] [1.88σ]  
Teffp = 3249 [358] K [6.14σ]

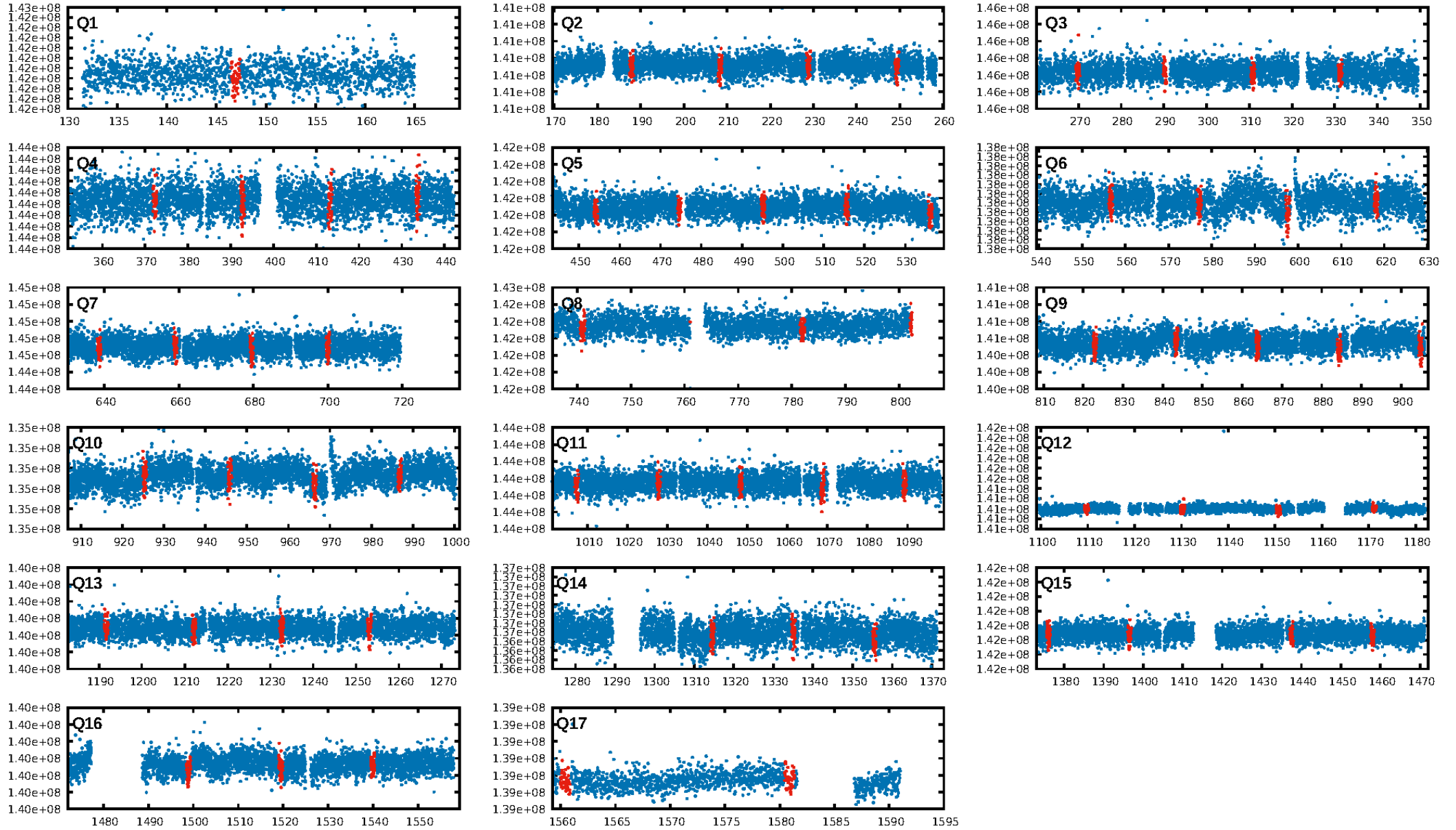
## DV Diagnostic Results:

ShortPeriod-sig: 100.0% [24.40σ]  
LongPeriod-sig: N/A  
ModelChiSquare2-sig: 96.7%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 9.00e-29  
RollingBand-fgt: 1.00 [53/53]  
GhostDiagnostic-chr: 3.013  
Centroid-sig: 18.0%  
Centroid-so: 0.598 arcsec [0.76σ]  
OotOffset-rm: 0.560 arcsec [0.45σ]  
KicOffset-rm: 0.820 arcsec [0.67σ]  
OotOffset-st: 4/3/2/4 [13]  
KicOffset-st: 4/3/2/4 [13]  
DiffImageQuality-fgm: 0.46 [6/13]  
DiffImageOverlap-fno: 0.94 [15/16]

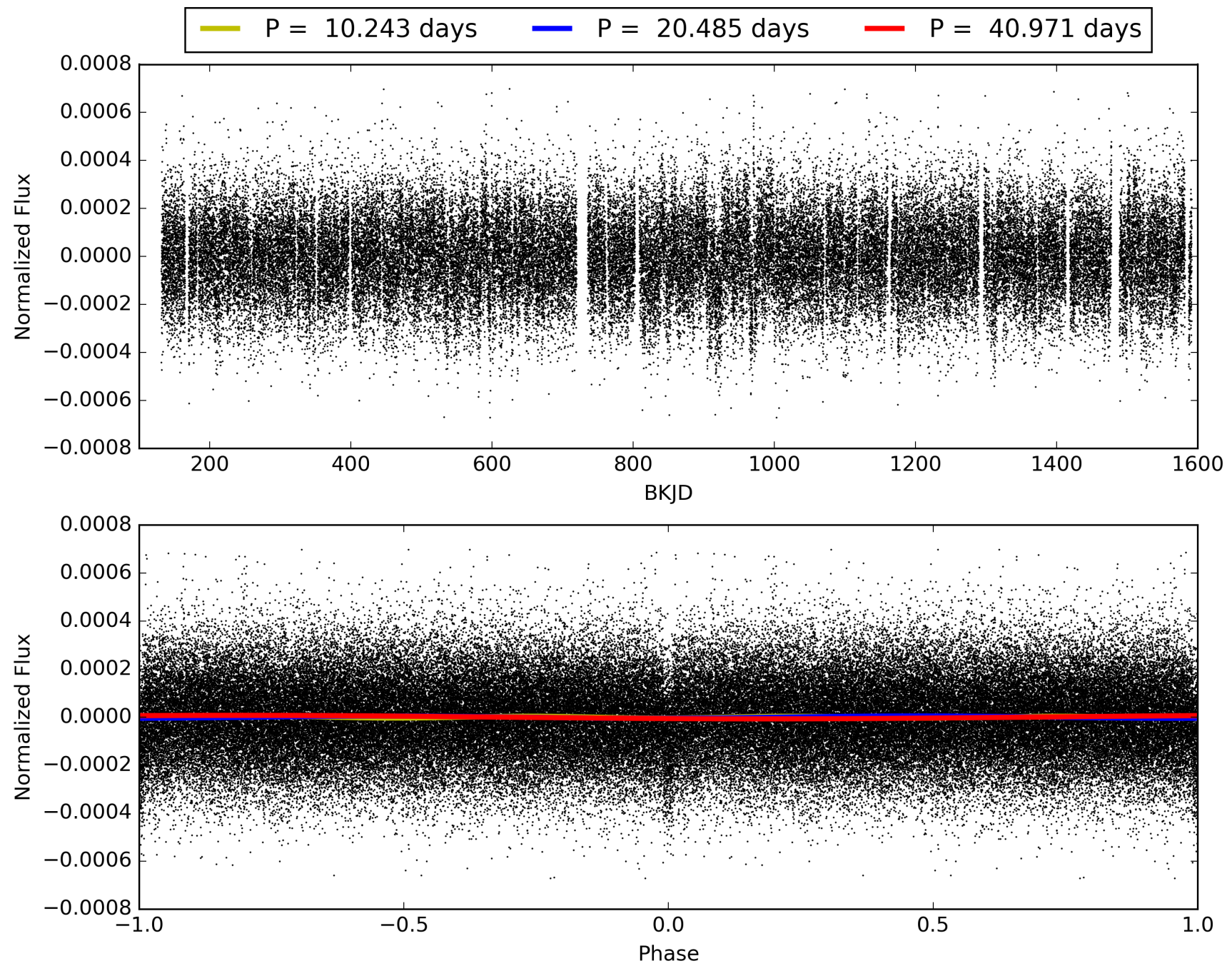
Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 28-Jan-2016 23:19:17 Z

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

# TCE 012306058-02, PDC Light Curves



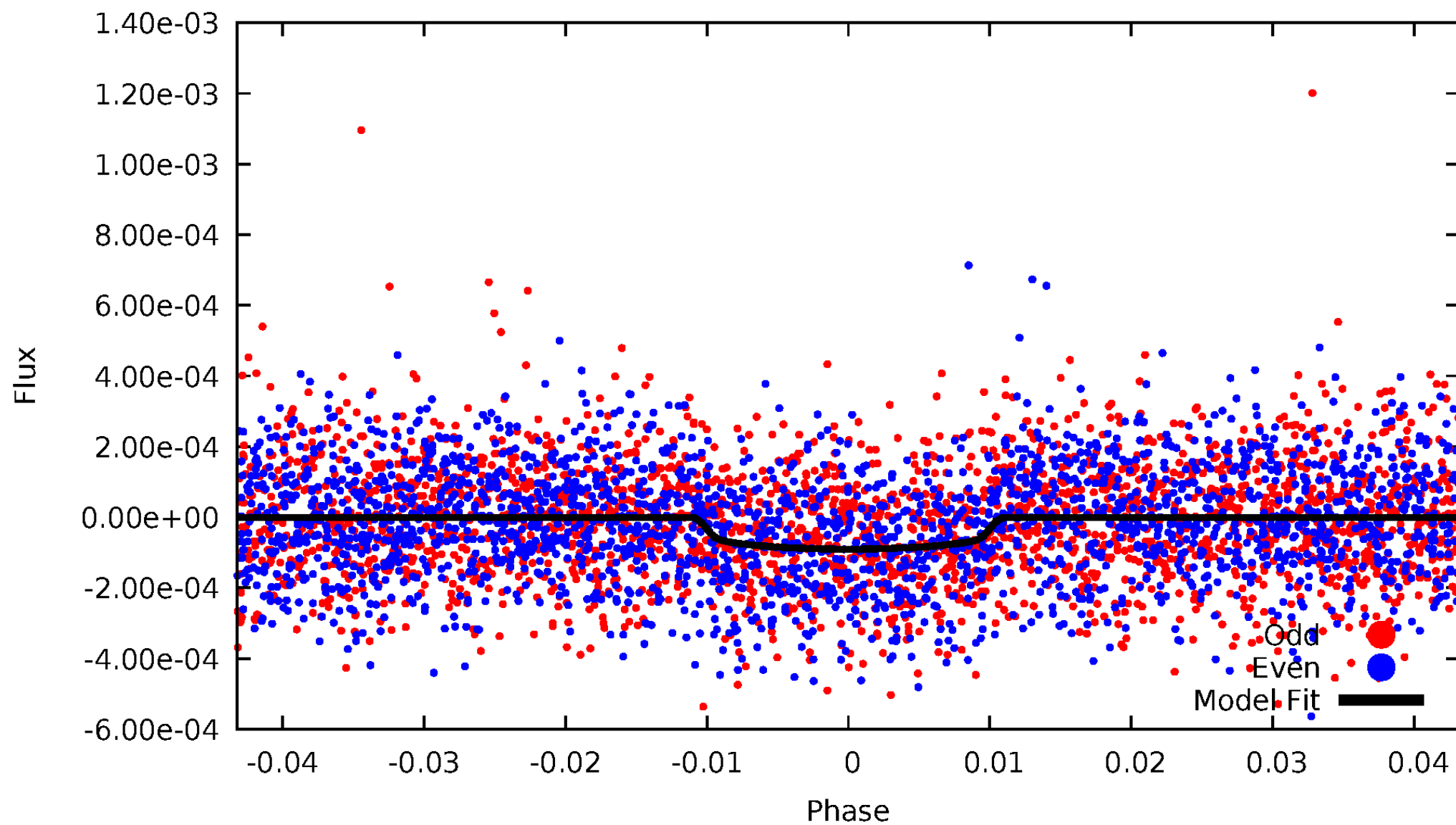
TCE 012306058-02





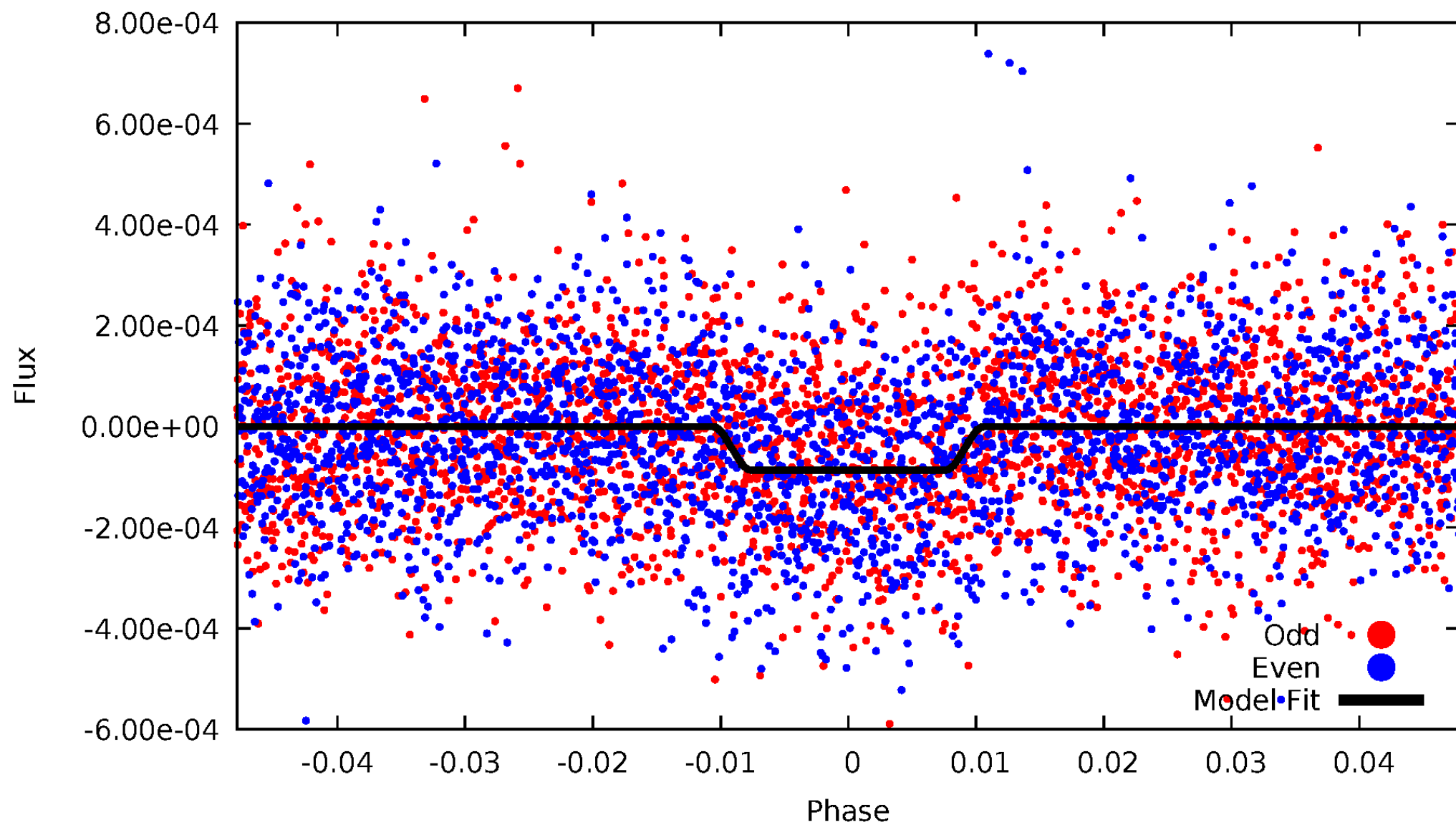
# DV Odd/Even

TCE 012306058-02



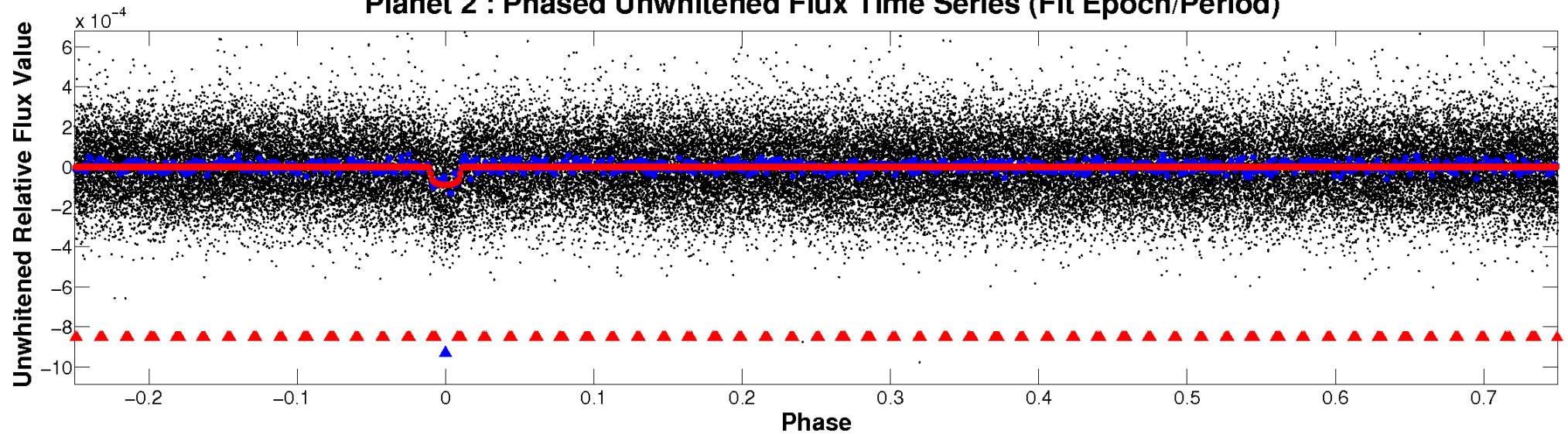
# ALT Odd/Even

TCE 012306058-02

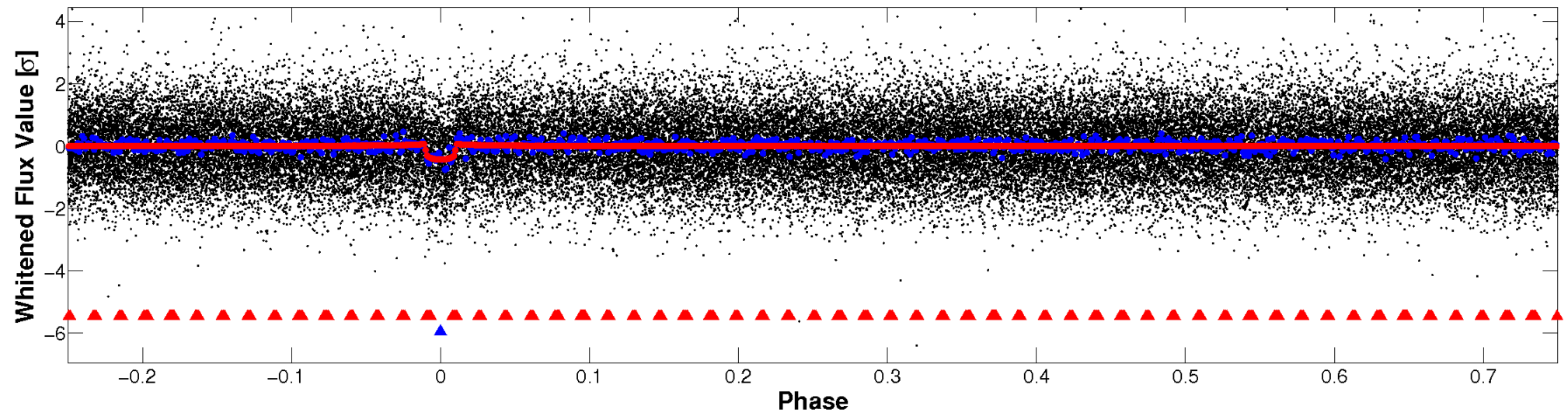


# Non-Whitened Vs. Whitened Light Curve

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



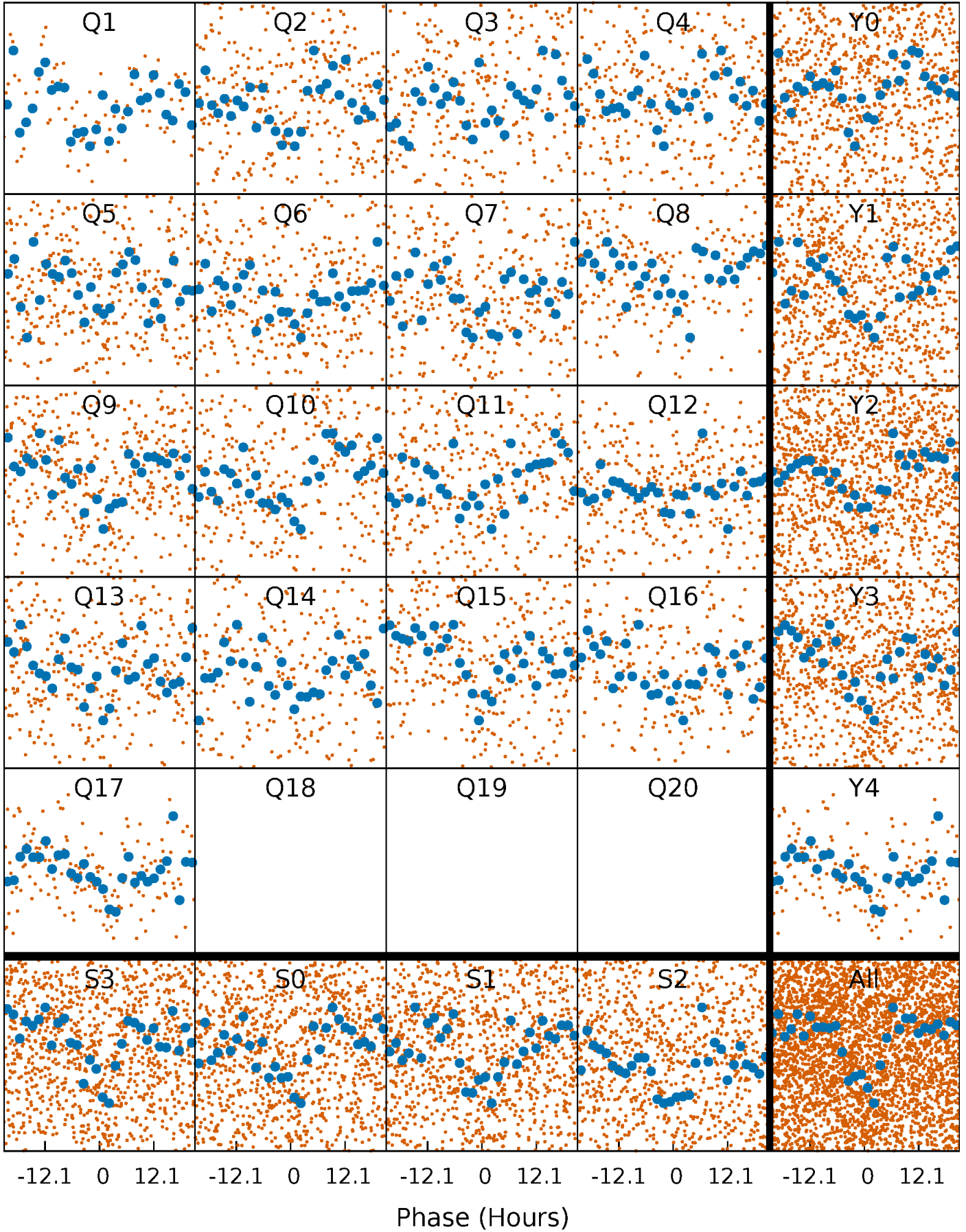
## Planet 2 : Phased Whitened Flux Time Series (Fit Epoch/Period)





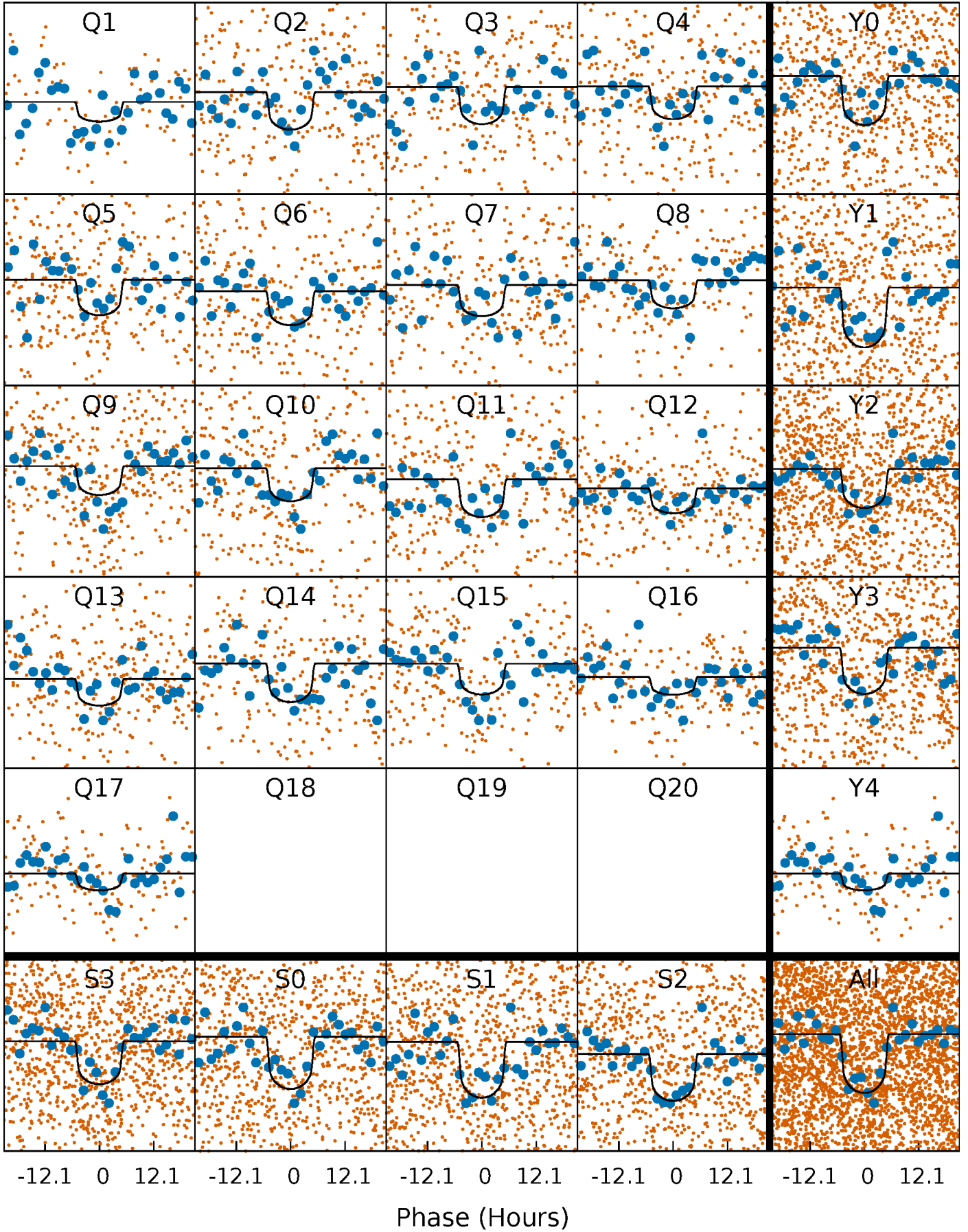
# PDC Quarter-Phased Transit Curves

TCE 012306058-02   P= 20.485328 Days    $T_0=146.925855$  (BKJD)



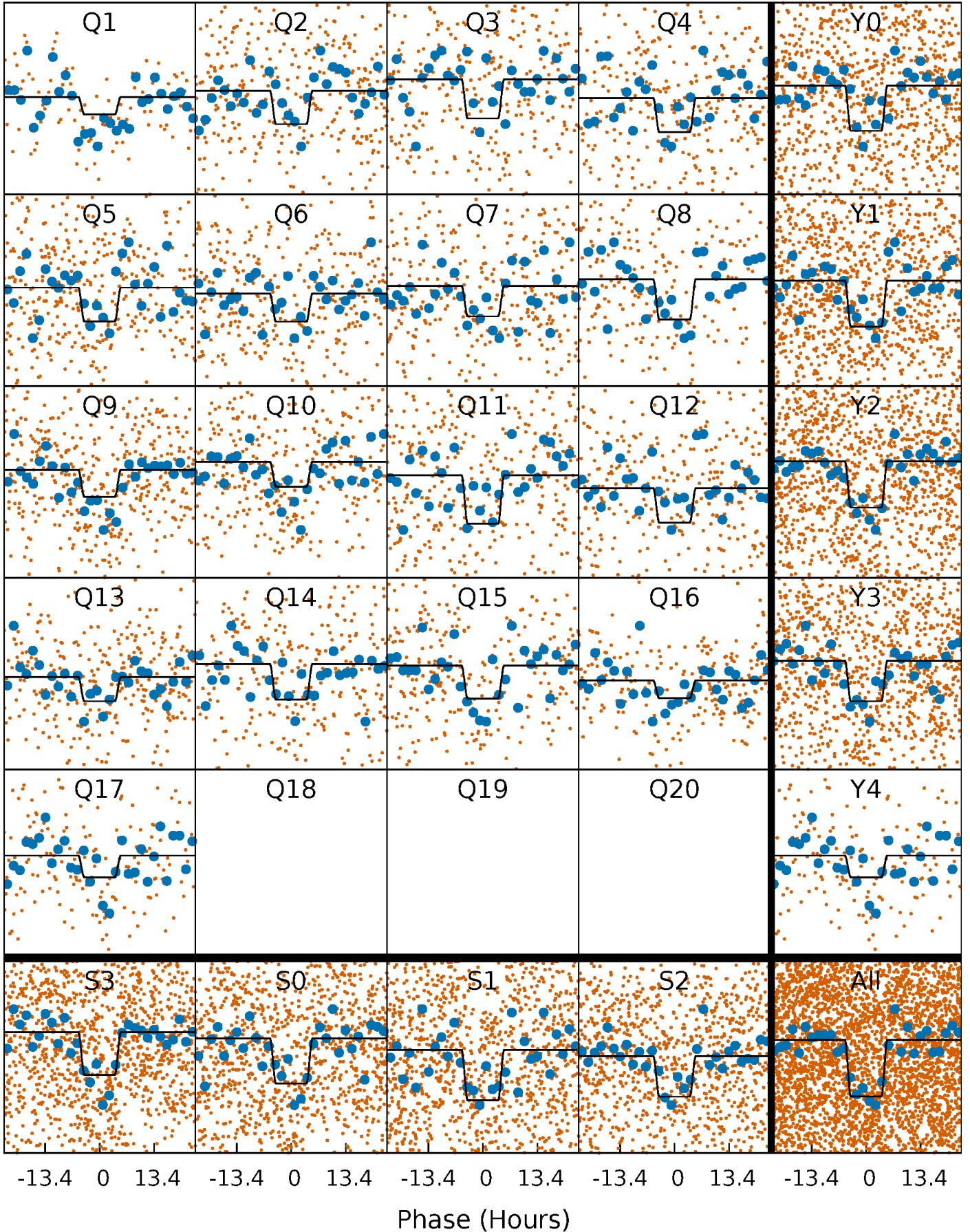
# DV Quarter-Phased Transit Curves

TCE 012306058-02   P= 20.485328 Days    $T_0=146.925855$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

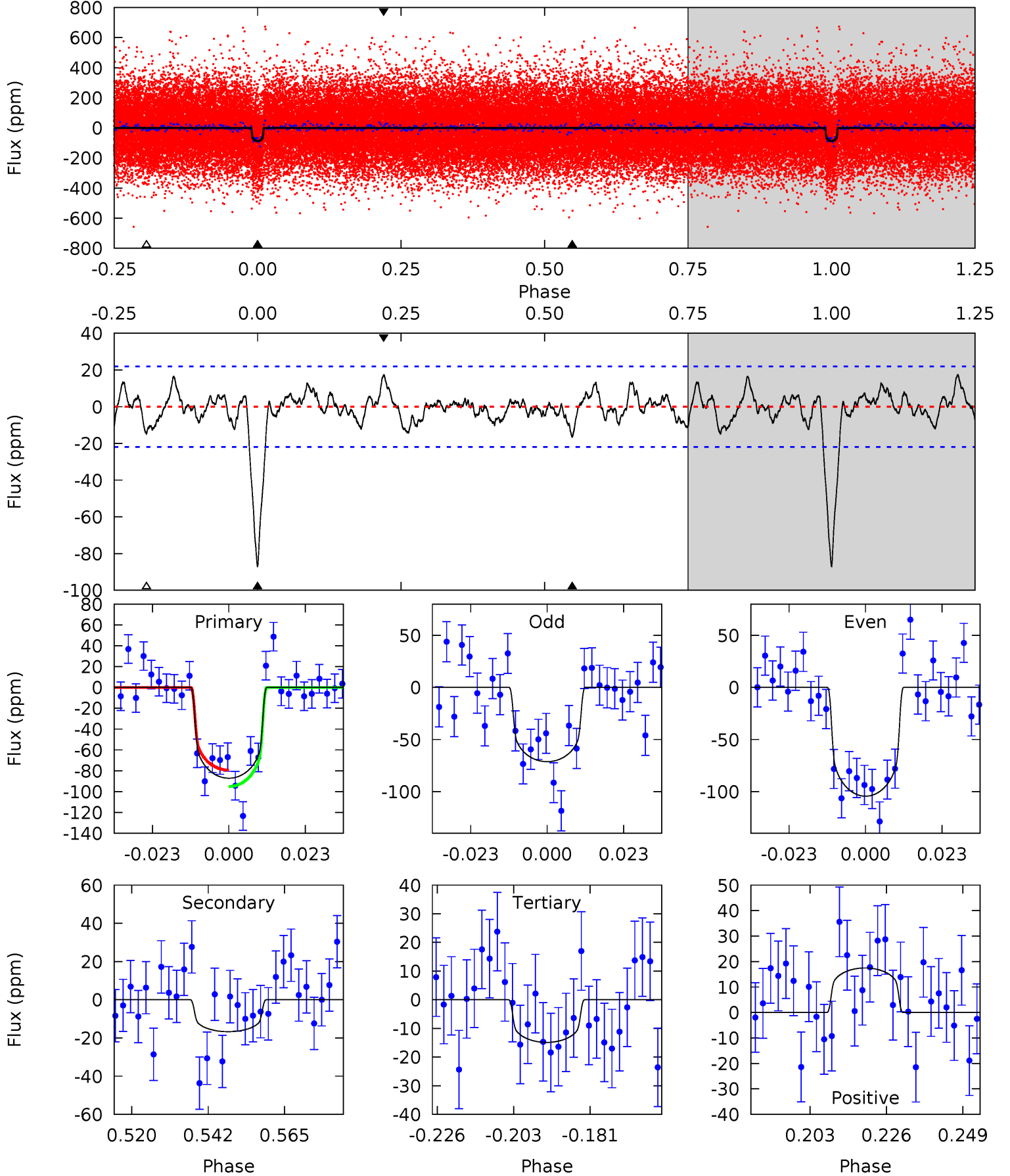
TCE 012306058-02 P= 20.486722 Days  $T_0=146.866812$  (BKJD)



# DV Model-Shift Uniqueness Test

012306058-02,  $P = 20.485328$  Days,  $E = 126.440527$  Days

| Pri  | Sec  | Ter  | Pos  | FA <sub>1</sub> | FA <sub>2</sub> | F <sub>Red</sub> | Pri-Ter | Pri-Pos | Sec-Ter | Sec-Pos | Odd-Evn | DMM  | Shape | TAT  |
|------|------|------|------|-----------------|-----------------|------------------|---------|---------|---------|---------|---------|------|-------|------|
| 19.3 | 3.71 | 3.30 | 3.88 | 4.87            | 2.28            | 1.33             | 16.0    | 15.5    | 0.41    | -0.17   | 3.68    | 1.05 | 0.17  | 1.75 |

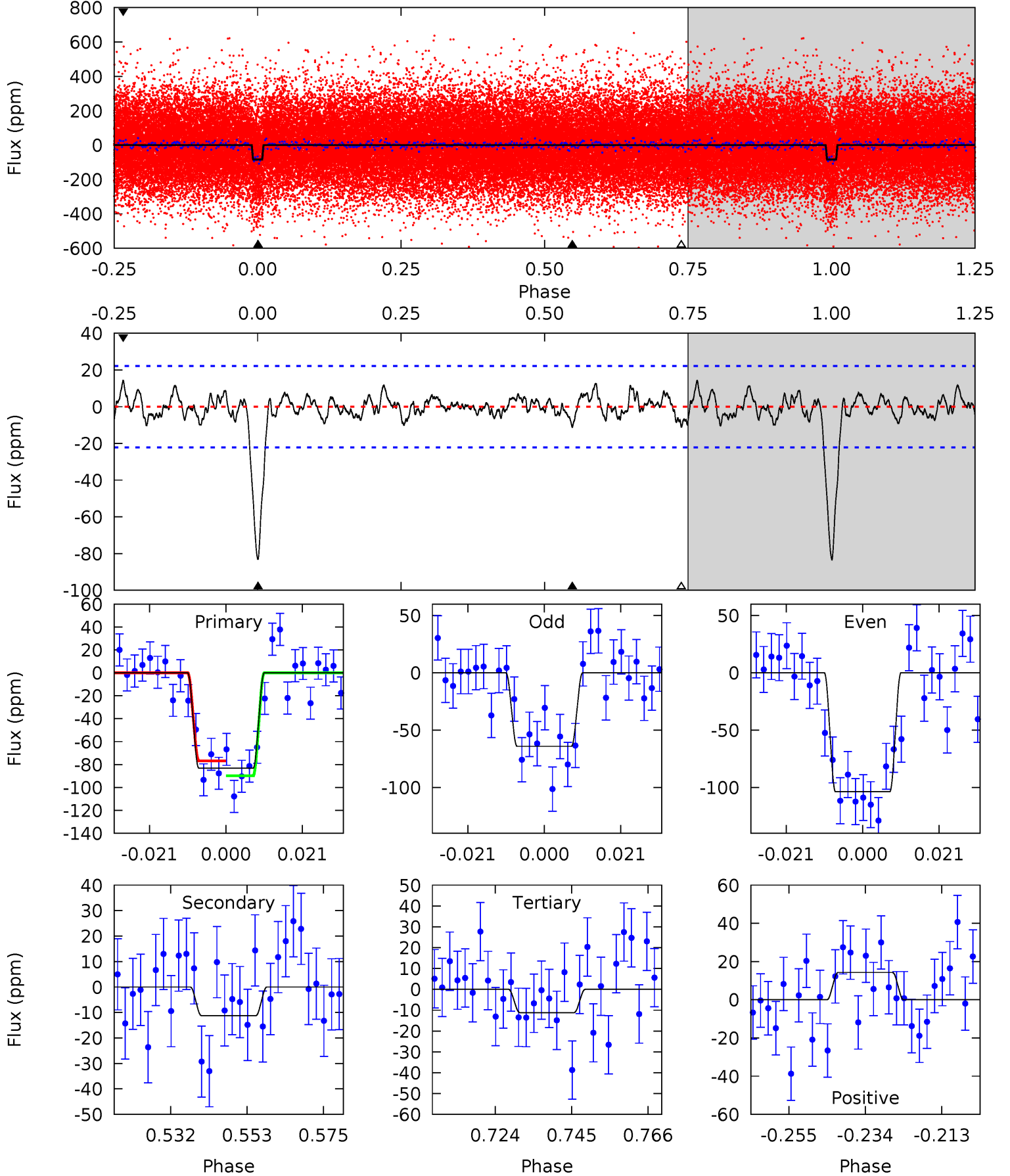




# Alt Model-Shift Uniqueness Test

012306058-02, P = 20.486722 Days, E = 126.380090 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  |
|------|------|------|------|-----------------|-----------------|------------------|---------|---------|---------|---------|---------|------|-------|------|
| 18.3 | 2.48 | 2.46 | 3.15 | 4.88            | 2.30            | 1.02             | 15.9    | 15.2    | 0.02    | -0.67   | 4.36    | 1.08 | 0.15  | 1.43 |



### Stellar Parameters For KIC 012306058

|        | $T_{\text{eff}}(K)$ | $\log(g)$                 | [Fe/H]                    | $R (R_{\odot})$           | $M(M_{\odot})$            | $p_{\star} (\text{g}\cdot\text{cm}^{-3})$ |
|--------|---------------------|---------------------------|---------------------------|---------------------------|---------------------------|---|
|        | $4938^{+69}_{-79}$  | $3.450^{+0.143}_{-0.130}$ | $0.000^{+0.150}_{-0.150}$ | $3.324^{+0.613}_{-0.551}$ | $1.136^{+0.170}_{-0.153}$ | $0.044^{+0.030}_{-0.017}$                 |
|        | +1%/-2%             | +4%/-4%                   | +inf%/-inf%               | +18%/-17%                 | +15%/-13%                 | +69%/-38%                                 |
| Source | SPE58               | SPE58                     | SPE58                     | DSEP                      |                           |   |

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

### Secondary Eclipse Parameters for KIC 012306058-02 / KOI 2541.02

| Detrend | Depth (ppm) | $R_p (R_{\oplus})$     | $T_{\text{max}} (K)$ | $T_{\text{obs}} (K)$ | $A_{\text{obs}}$ |
|---------|-------------|------------------------|----------------------|----------------------|------------------|
| DV      | $-17 \pm 5$ | $3.93^{+0.82}_{-0.62}$ | $1420^{+72}_{-77}$   | $3438^{+225}_{-222}$ | $13^{+7}_{-5}$   |
| Alt.    | $-11 \pm 5$ | $3.37^{+0.66}_{-0.66}$ | $1416^{+71}_{-69}$   | $3400^{+314}_{-309}$ | $13^{+10}_{-6}$  |

$T_{\text{max}}$  = 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

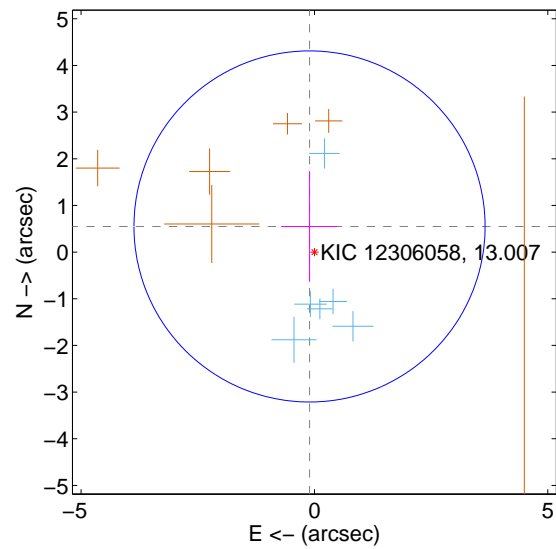
Supplemental centroid analysis for 012306058-02. Kepler magnitude: 13.01. Transit SNR 12.40

There are 6 quarters with good PRF difference image offsets

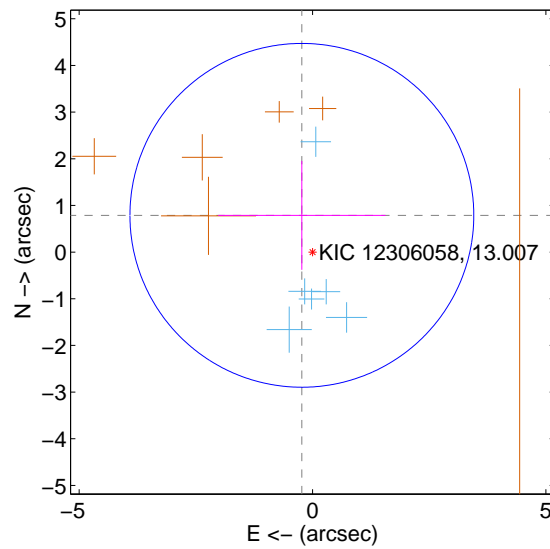
The direct PRF centroid is offset from the target star catalog position by about 0.29 arcsec

|   | Distance in arcsec | Distance / $\sigma$ | $\Delta$ RA       | $\Delta$ Dec      |
|---|--------------------|---------------------|-------------------|-------------------|
| PRF-fit source offset from OOT          | $0.560 \pm 1.254$  | 0.45                | $0.105 \pm 0.608$ | $0.550 \pm 1.186$ |
| PRF-fit source offset from KIC position | $0.820 \pm 1.228$  | 0.67                | $0.228 \pm 1.793$ | $0.788 \pm 1.168$ |
| photometric centroid source offset      | $0.60 \pm 0.79$    | 0.76                | $0.11 \pm 0.66$   | $-0.59 \pm 0.79$  |

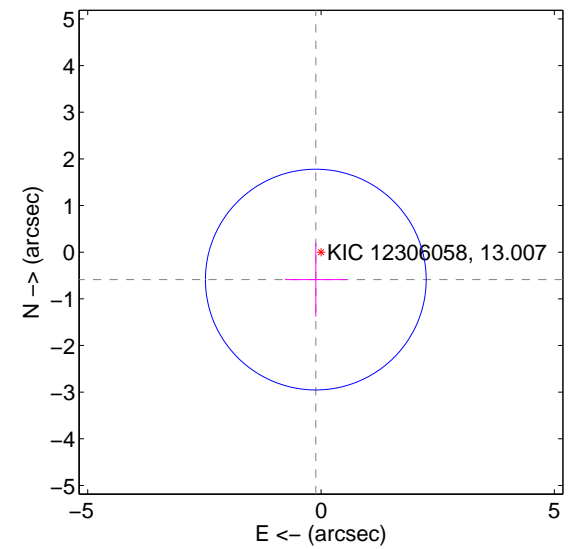
offset from difference PRF-fit to OOT PRF-fit



offset from difference PRF-fit to KIC position



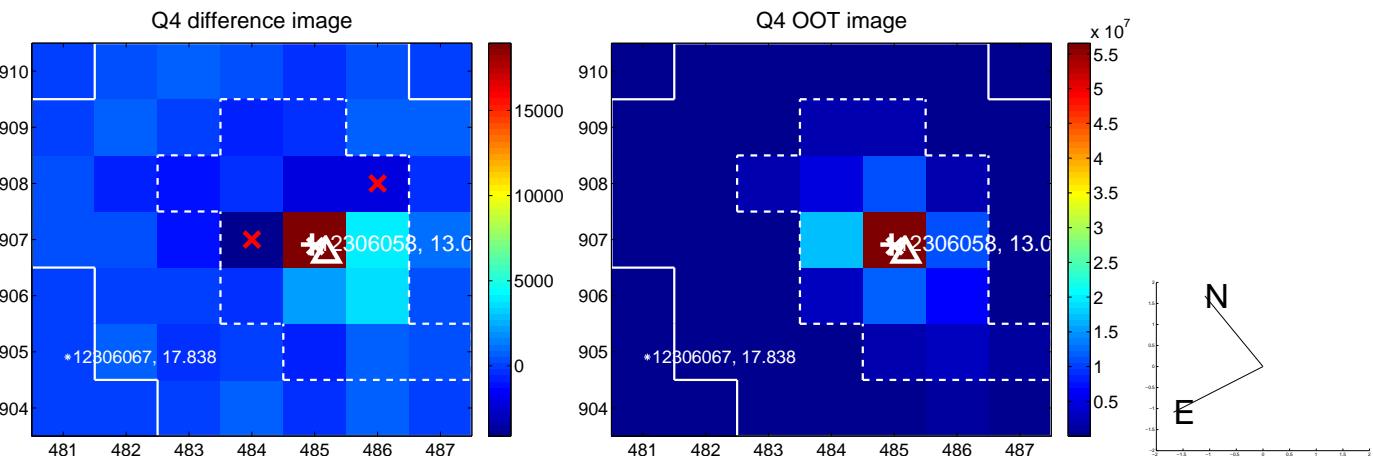
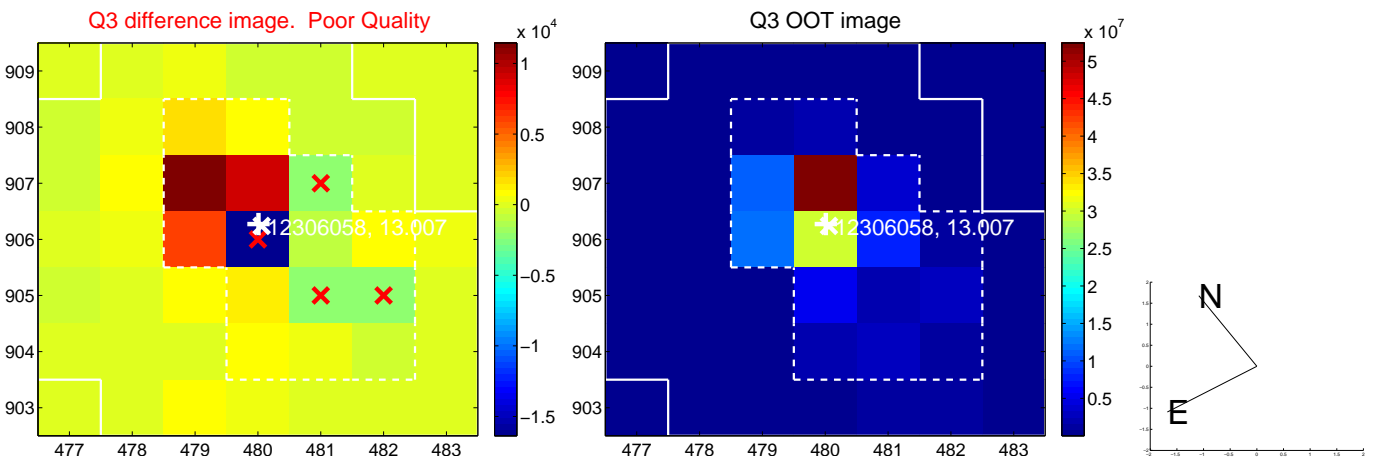
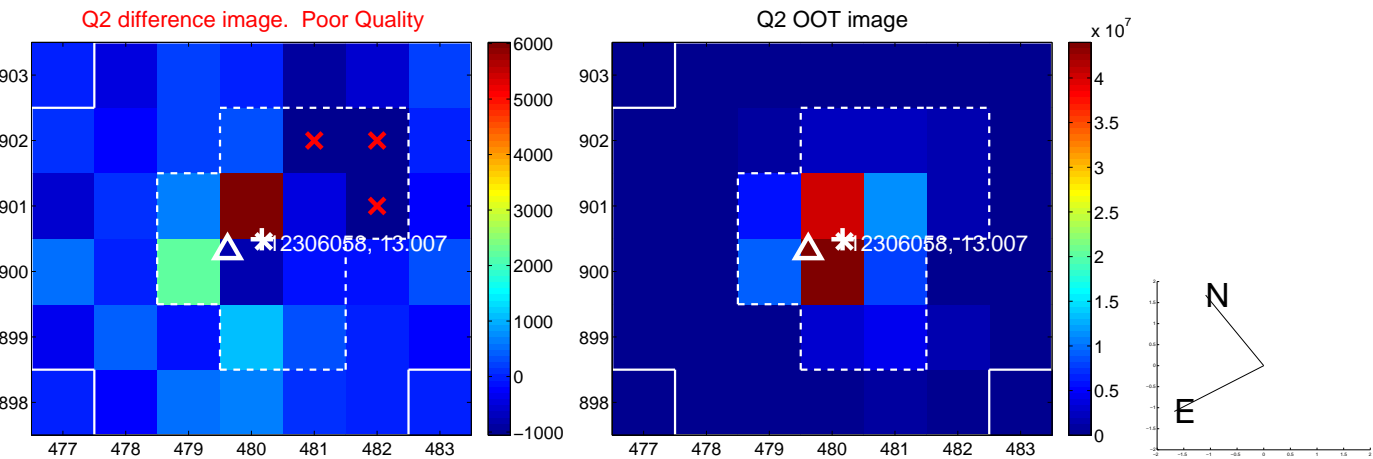
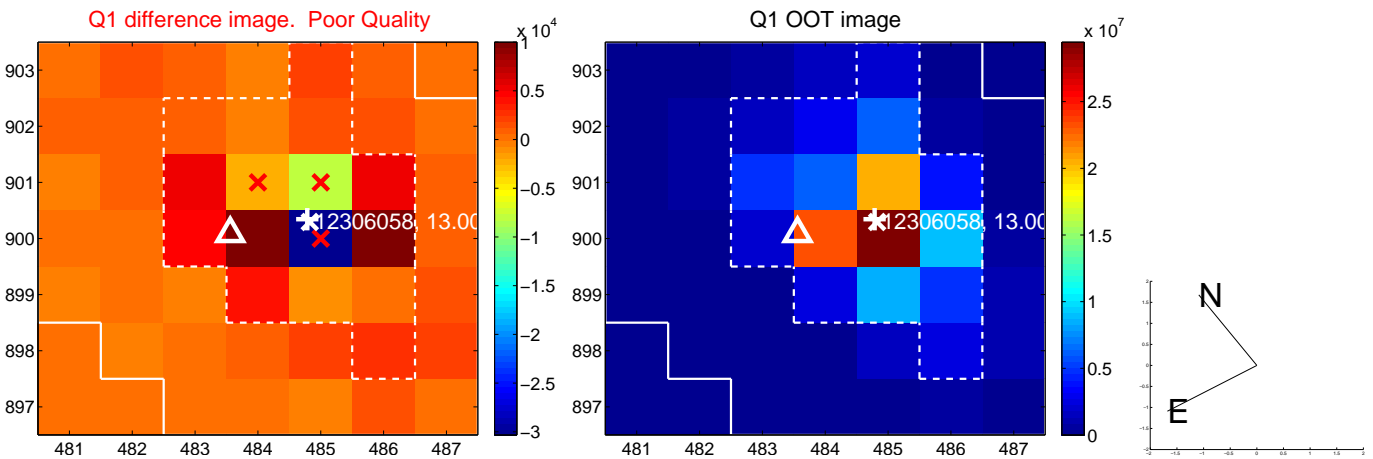
offset from photometric centroids



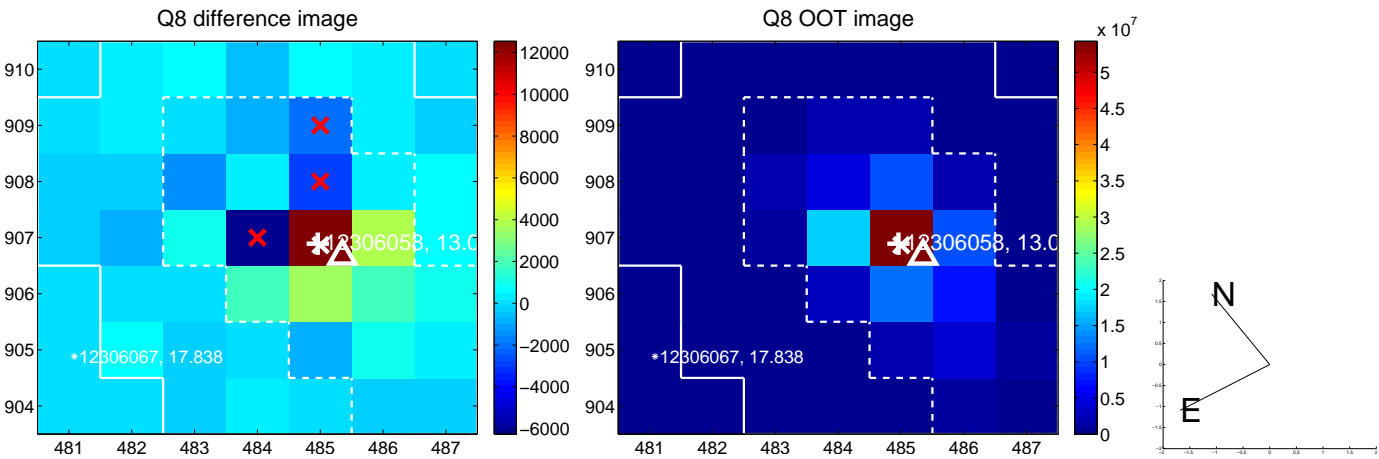
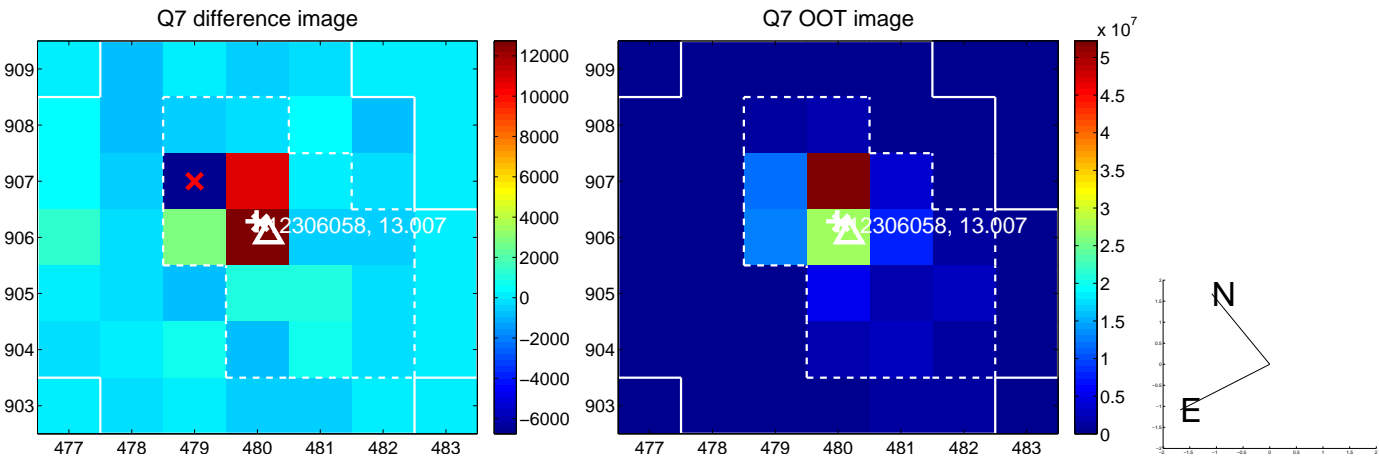
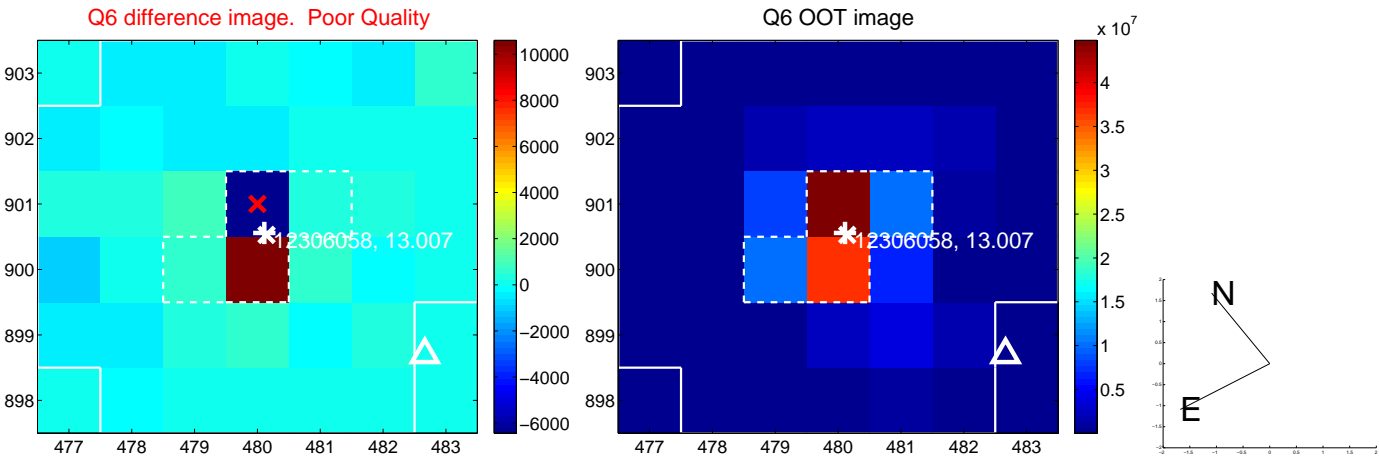
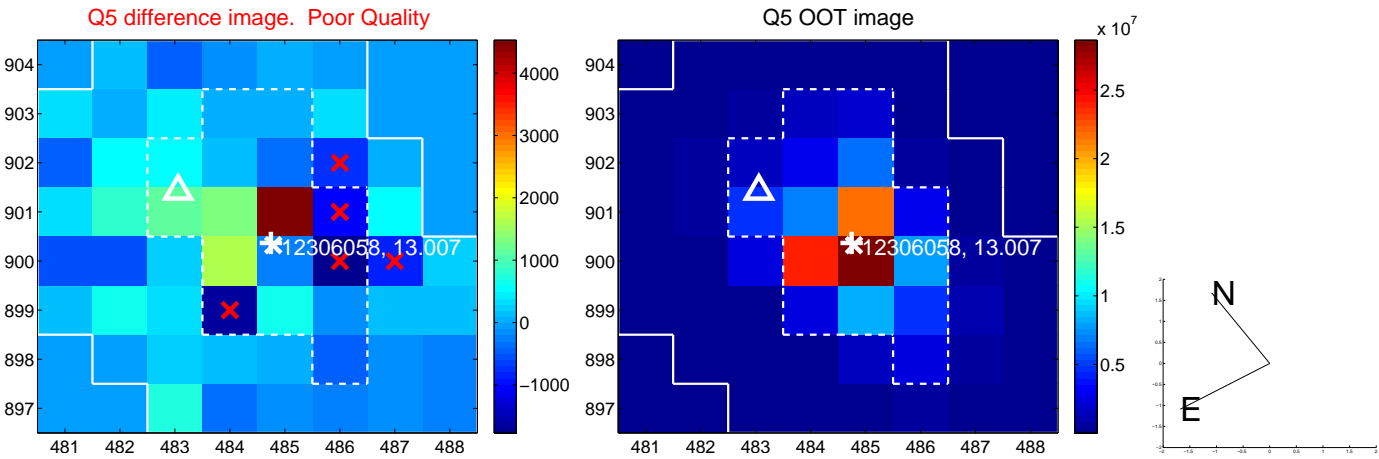
Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses: good quarterly centroid offsets**; **Vermillion crosses: bad quarterly centroid offsets**; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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



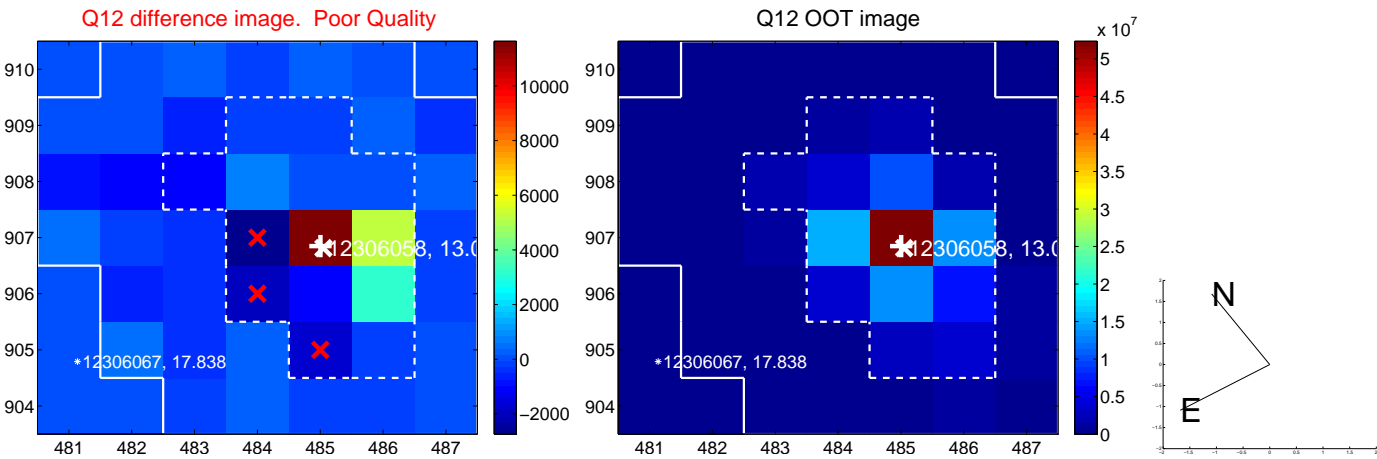
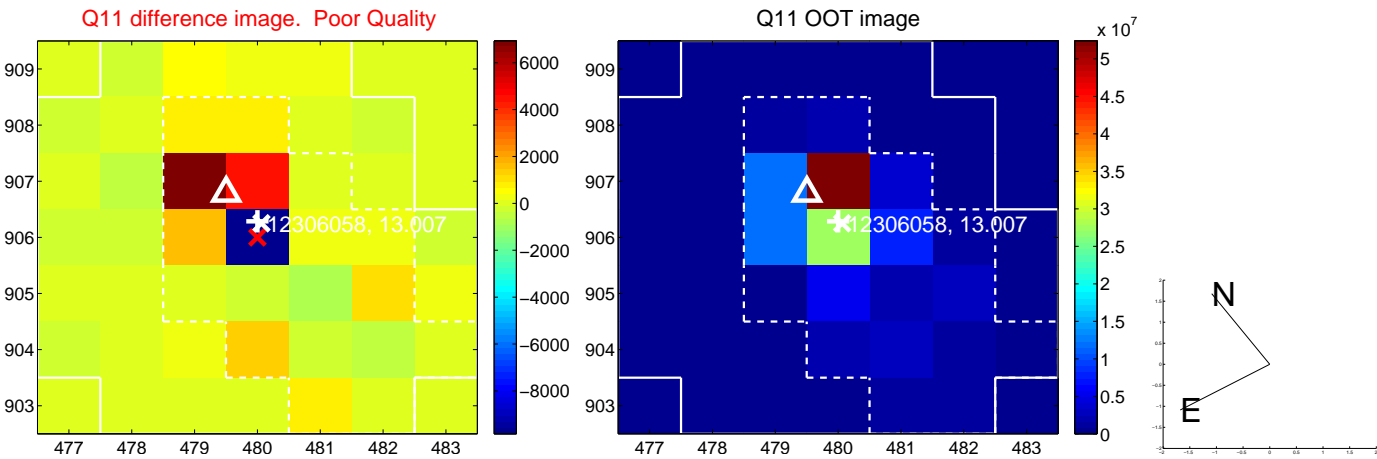
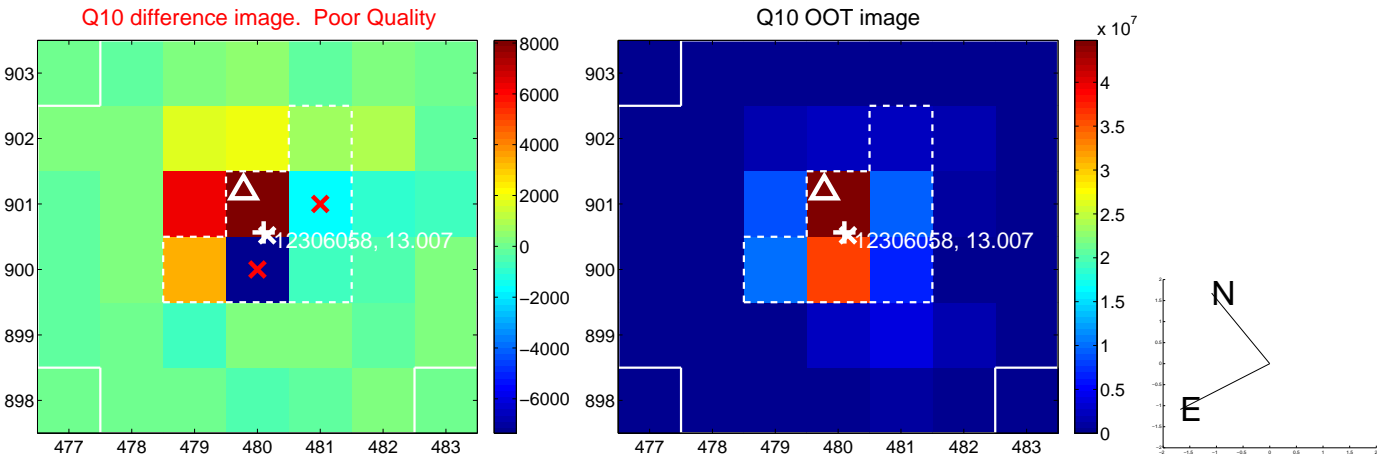
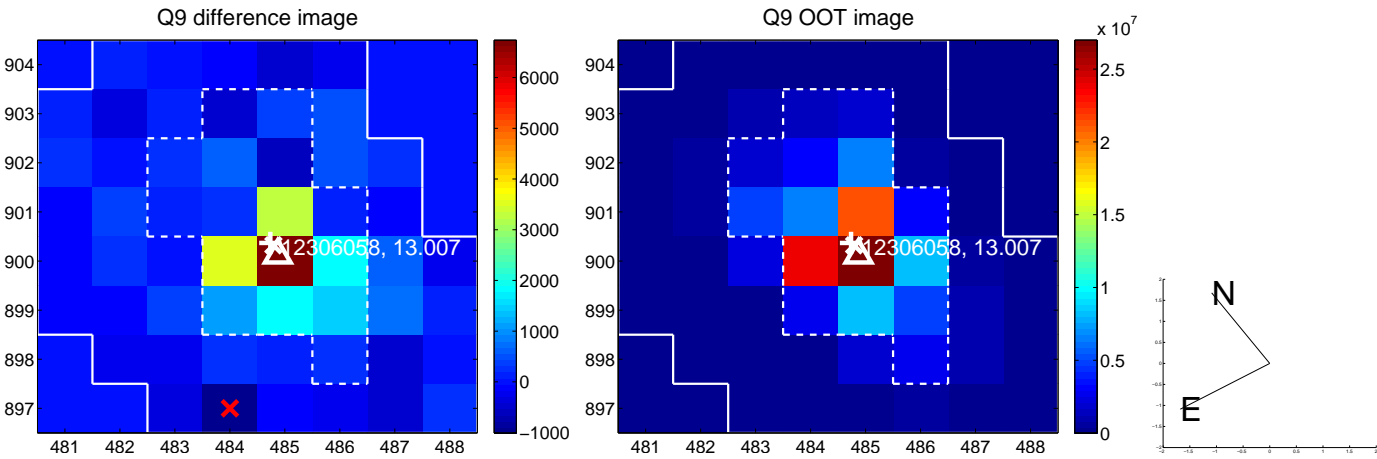
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



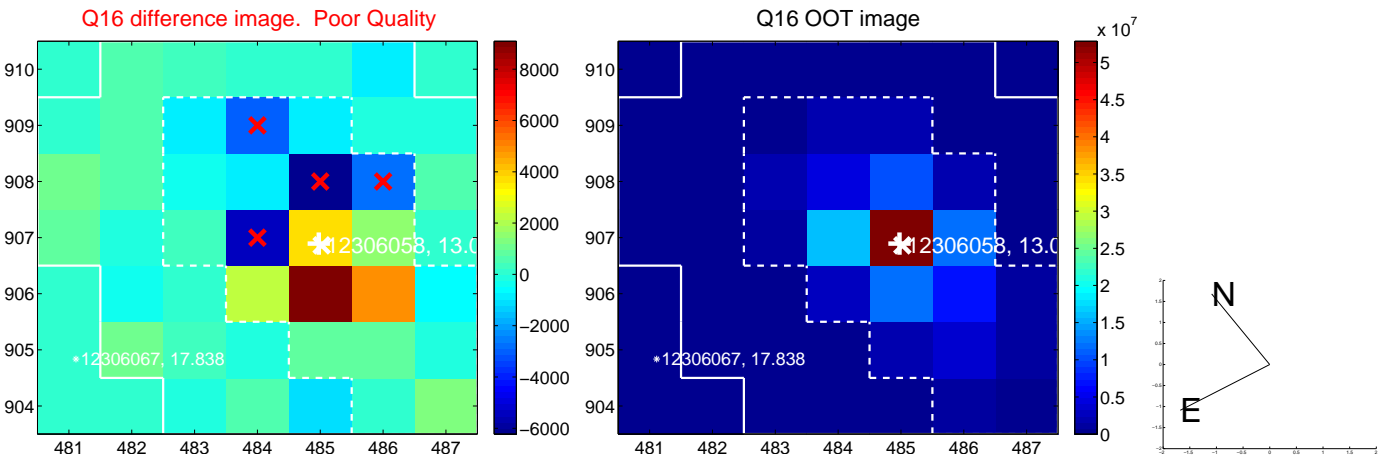
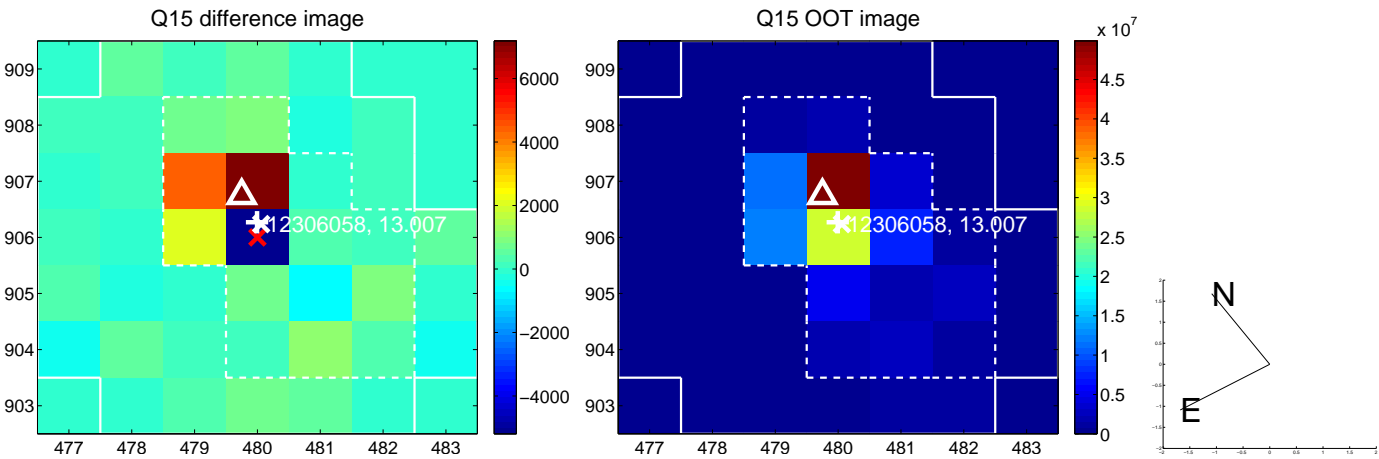
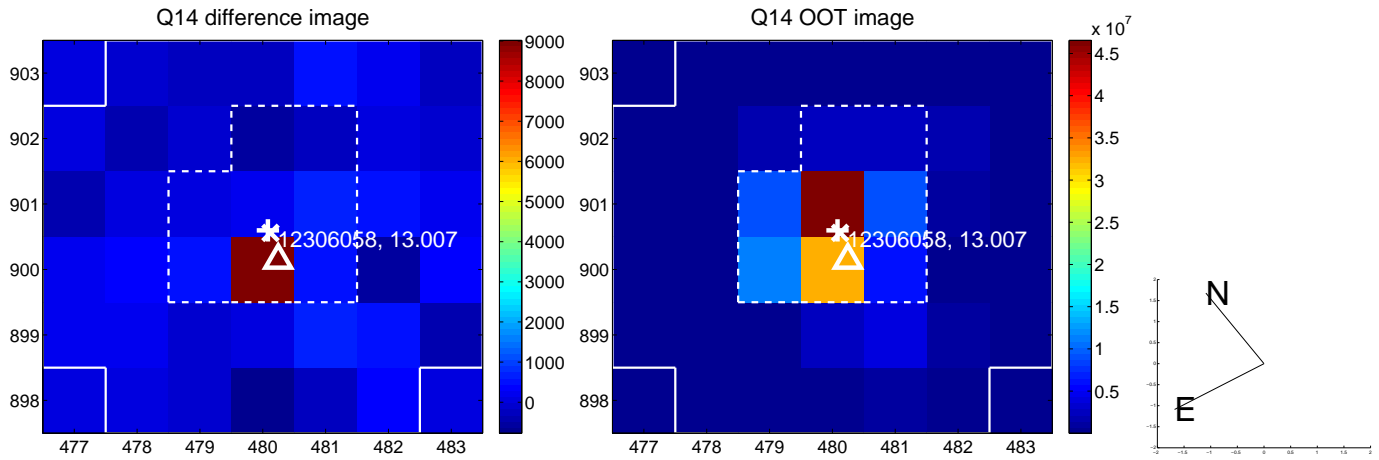
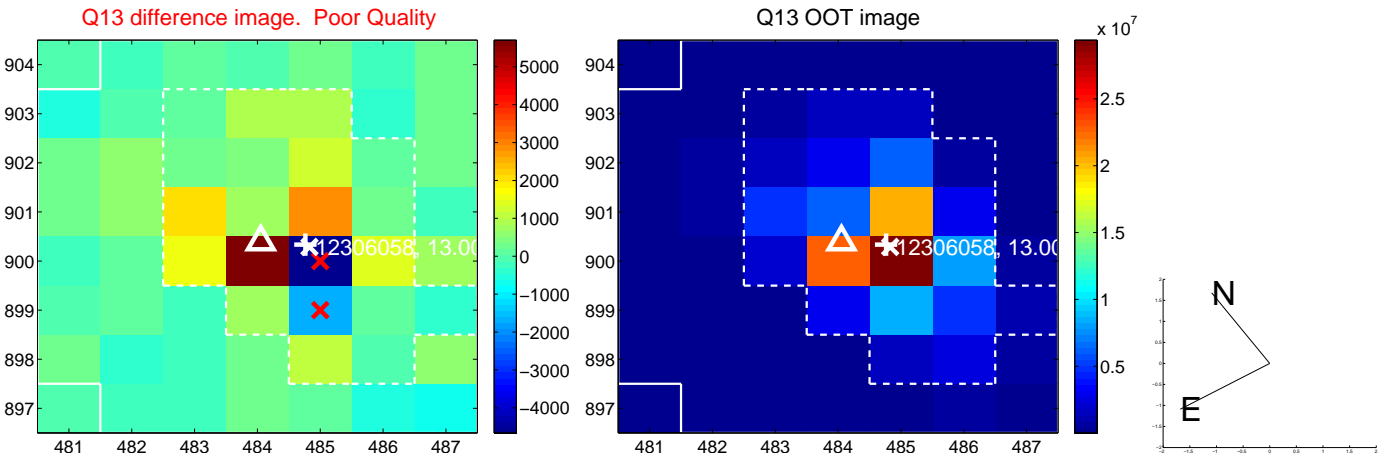
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



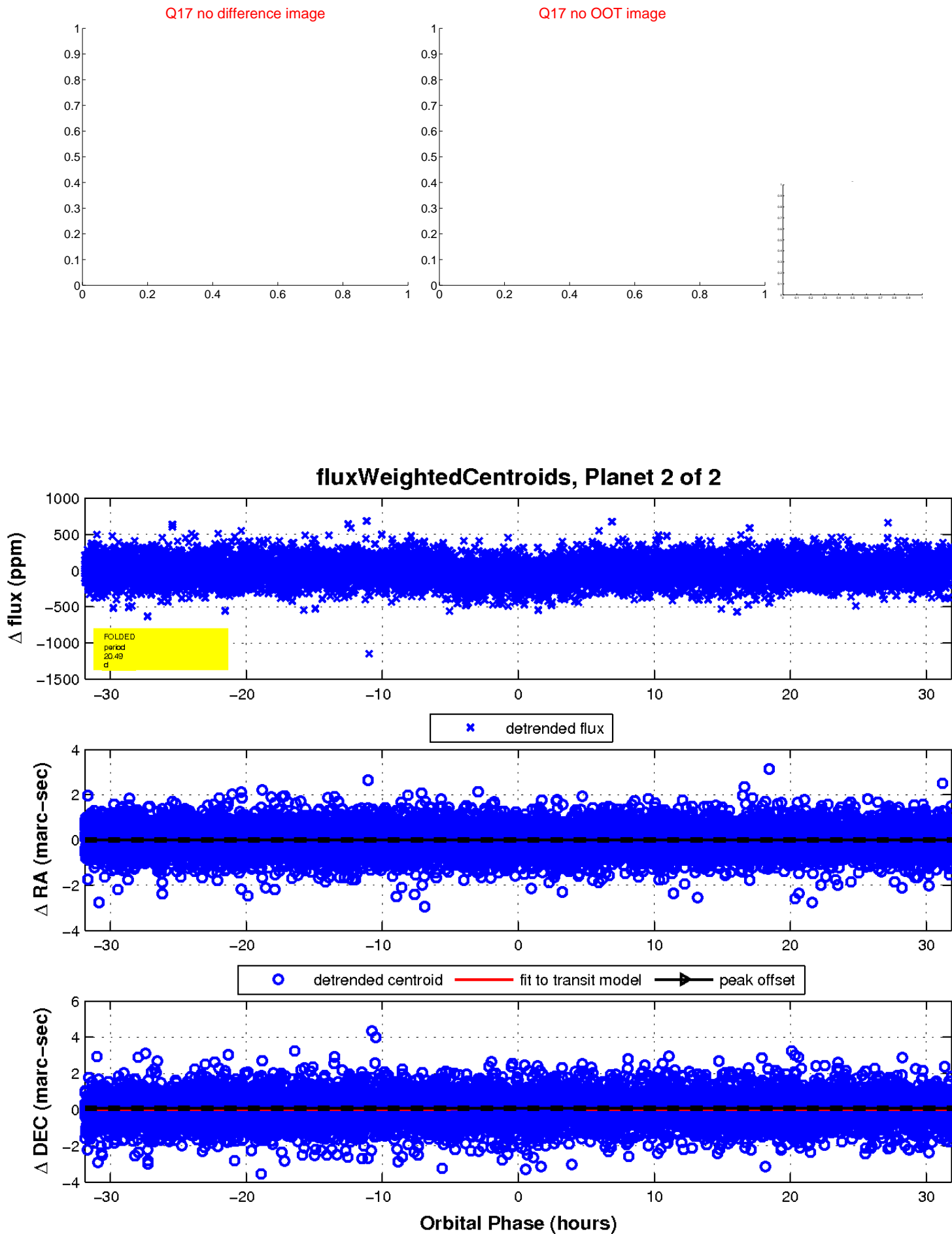
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

