

# KIC 008753657

## 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) | $R_p$ ( $R_{\oplus}$ ) | $S_p$ ( $S_{\oplus}$ ) |
|--------------|----------|---------|---------------|--------------|-------------|------------------|------|------|-----------------------------|-----------------|------------------------|------------------------|
| 008753657-01 | OBS      | 0321.01 | 2.426293      | 131.637238   | 162.6       | 2.652            | 65.8 | 76.2 | 0.97                        | 5678            | 1.48                   | 680.66                 |
| 008753657-02 | OBS      | 0321.02 | 4.623327      | 132.372896   | 63.2        | 3.006            | 20.6 | 22.0 | 0.97                        | 5678            | 0.91                   | 288.13                 |

## Robovetter Results

| TCE          | Run Type | Disp | Score | N | S | C | E | Comments   |
|--------------|----------|------|-------|---|---|---|---|------------|
| 008753657-01 | OBS      | PC   | 1.00  | 0 | 0 | 0 | 0 | NO_COMMENT |
| 008753657-02 | OBS      | PC   | 1.00  | 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.

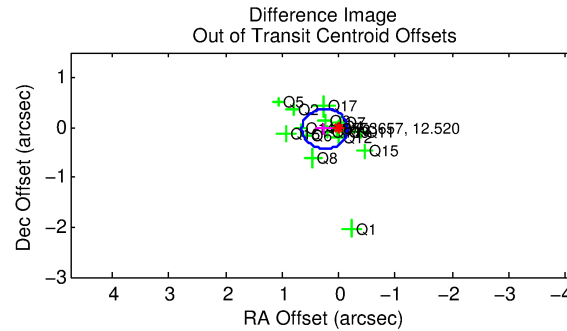
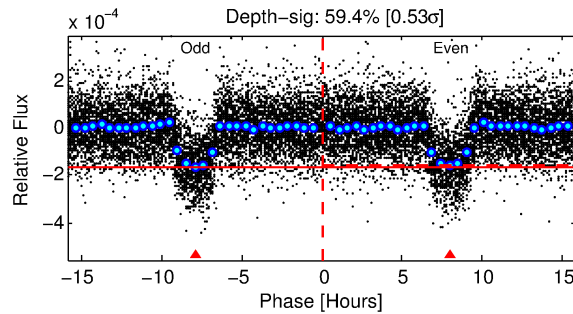
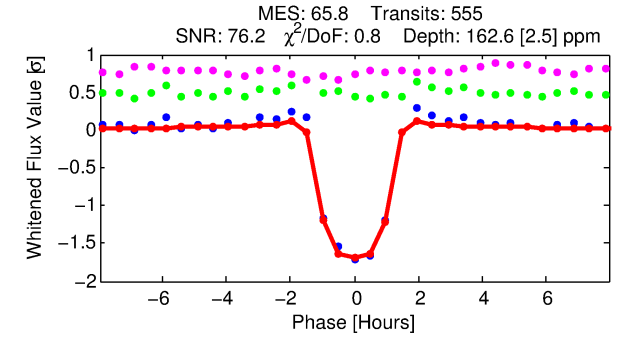
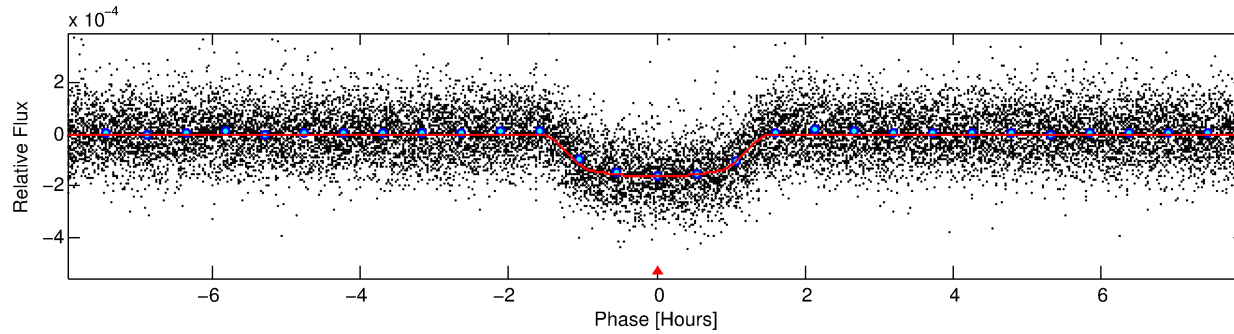
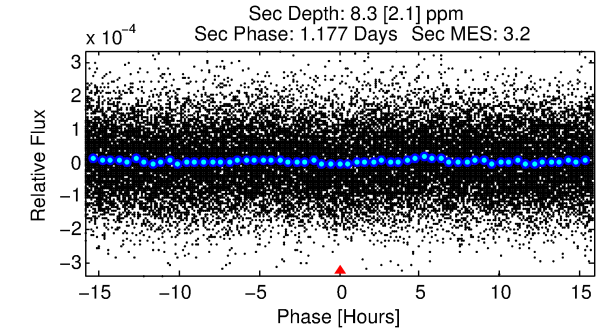
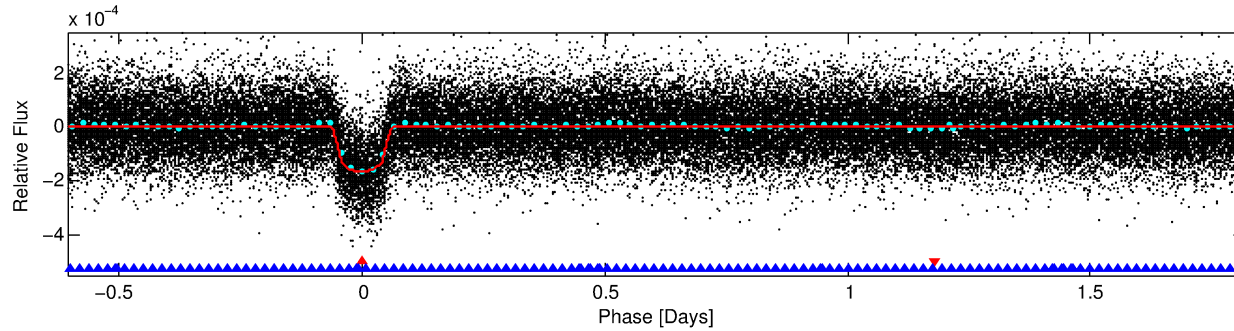
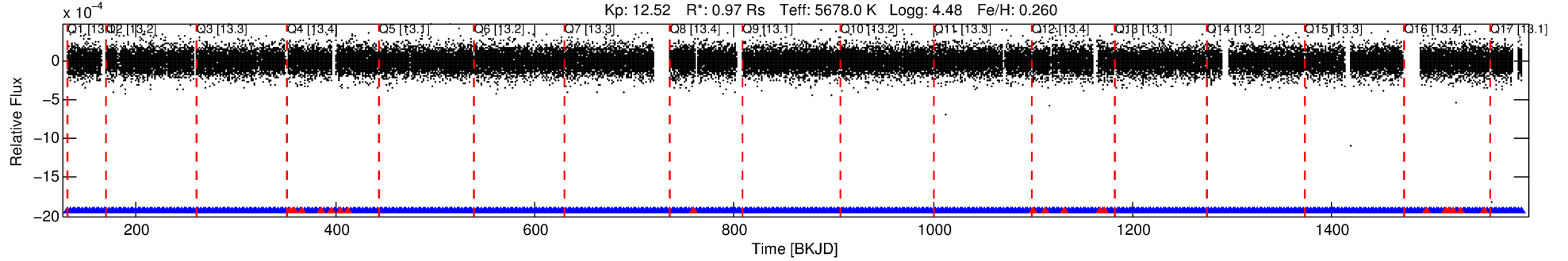
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 008753657-01

No Significant Match Found

# DV One-Page Summary

KIC: 8753657 Candidate: 1 of 2 Period: 2.426 d  
KOI: K00321.01 Name: Kepler-406b Corr: 0.986



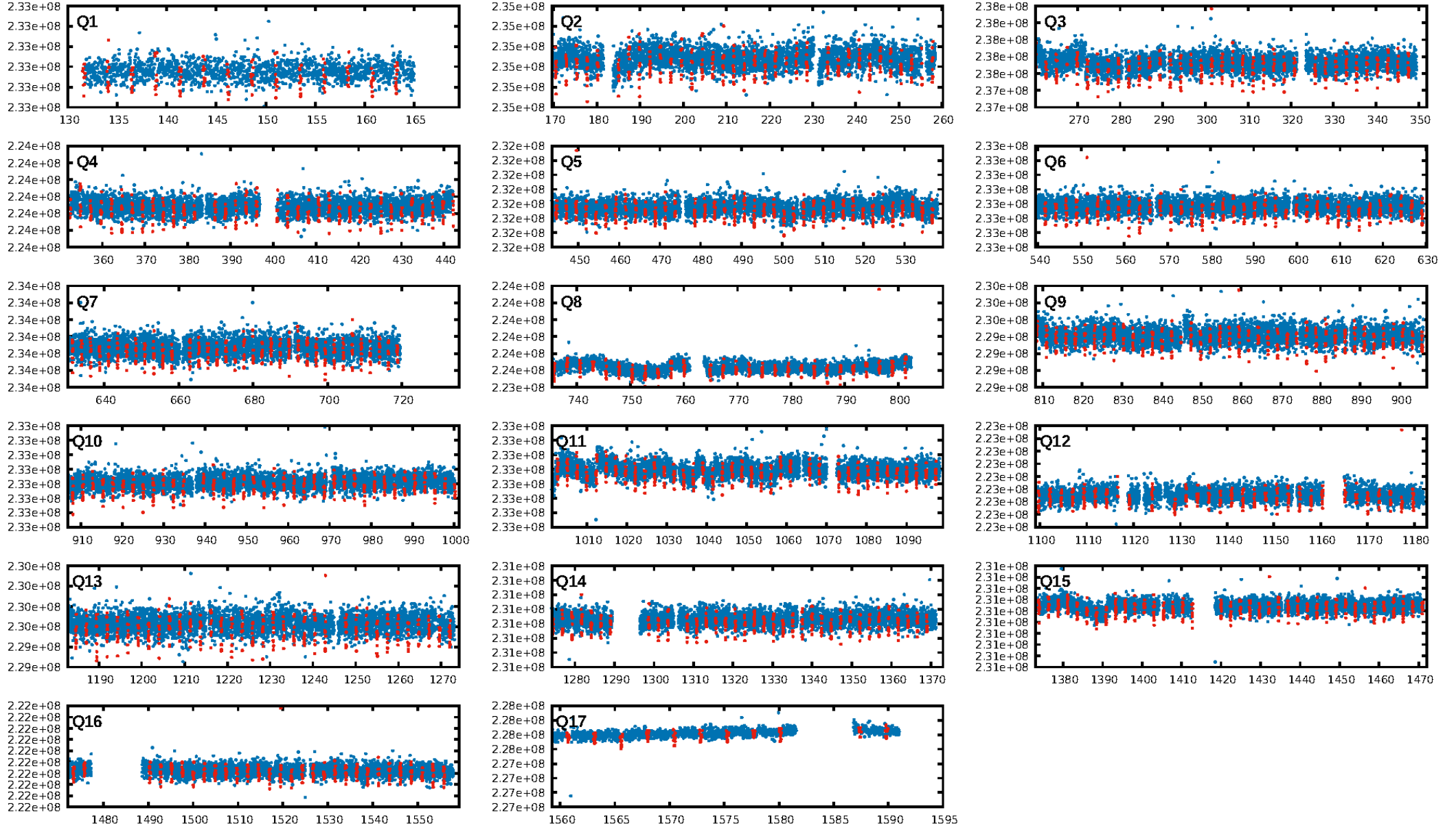
## DV Fit Results:

Period = 2.42629 [0.00000] d  
Epoch = 131.6372 [0.0005] BKJD  
Rp/R\* = 0.0140 [0.0012]  
a/R\* = 3.40 [1.26]  
b = 0.90 [0.09]  
Seff = 680.66 [155.50]  
Teq = 1302 [74] K  
Rp = 1.48 [0.26] Re  
a = 0.0359 [0.0050] AU  
Ag = 2.68 [1.00] [1.68σ]  
Teffp = 2578 [206] K [5.81σ]

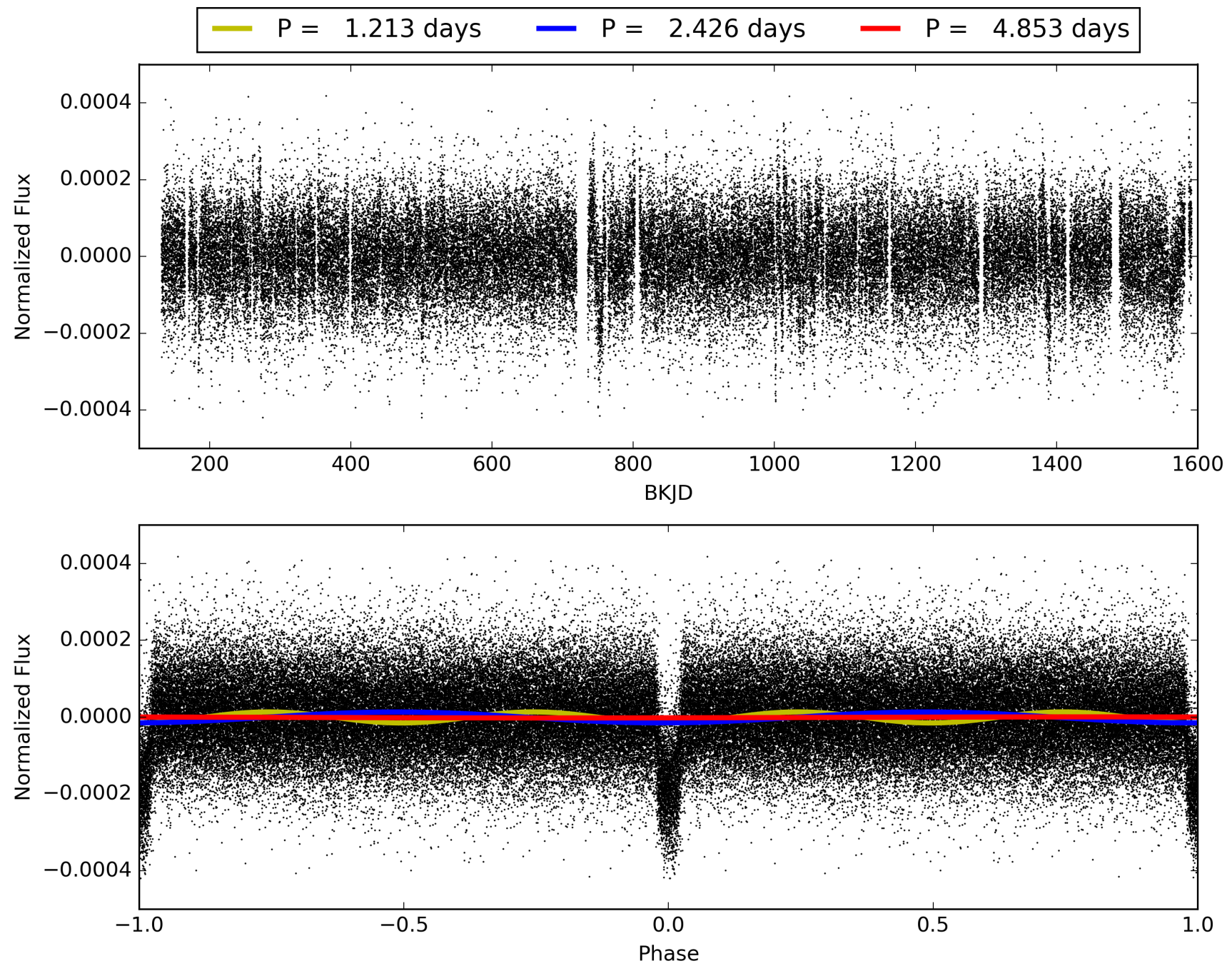
## DV Diagnostic Results:

ShortPeriod-sig: N/A  
LongPeriod-sig: 100.0% [13.15σ]  
ModelChiSquare2-sig: N/A  
ModelChiSquareGof-sig: N/A  
Bootstrap-pfa: 0.00e+00  
RollingBand-fgt: 0.96 [510/530]  
GhostDiagnostic-chr: 8.475  
Centroid-sig: 11.2%  
Centroid-so: 0.459 arcsec [2.61σ]  
OotOffset-rm: 0.253 arcsec [1.90σ]  
KicOffset-rm: 0.496 arcsec [3.44σ]  
OotOffset-st: 4/4/4/5 [17]  
KicOffset-st: 4/4/4/5 [17]  
DiffImageQuality-fgm: 1.00 [17/17]  
DiffImageOverlap-fno: 1.00 [17/17]

# TCE 008753657-01, PDC Light Curves

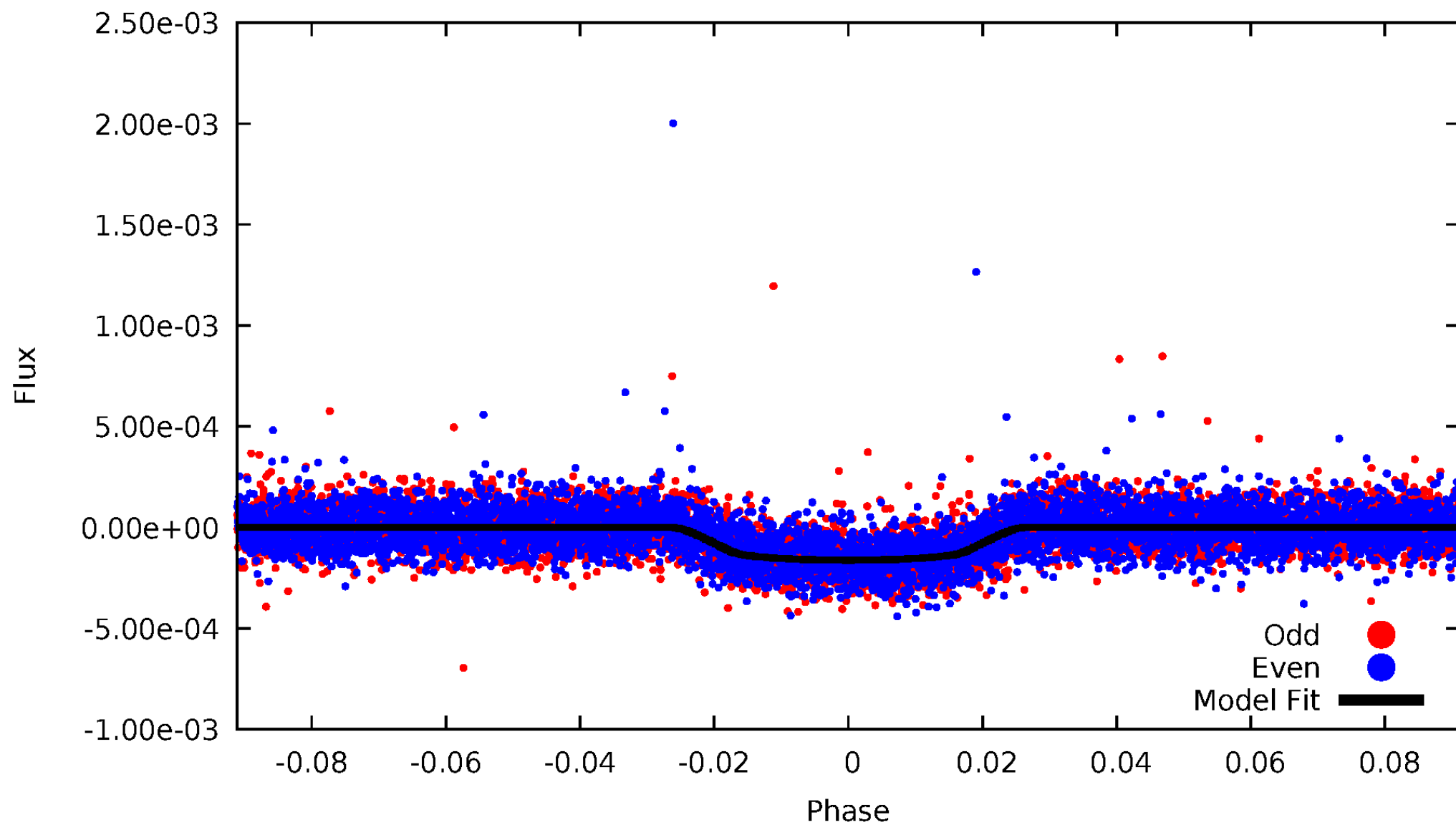


TCE 008753657-01



# DV Odd/Even

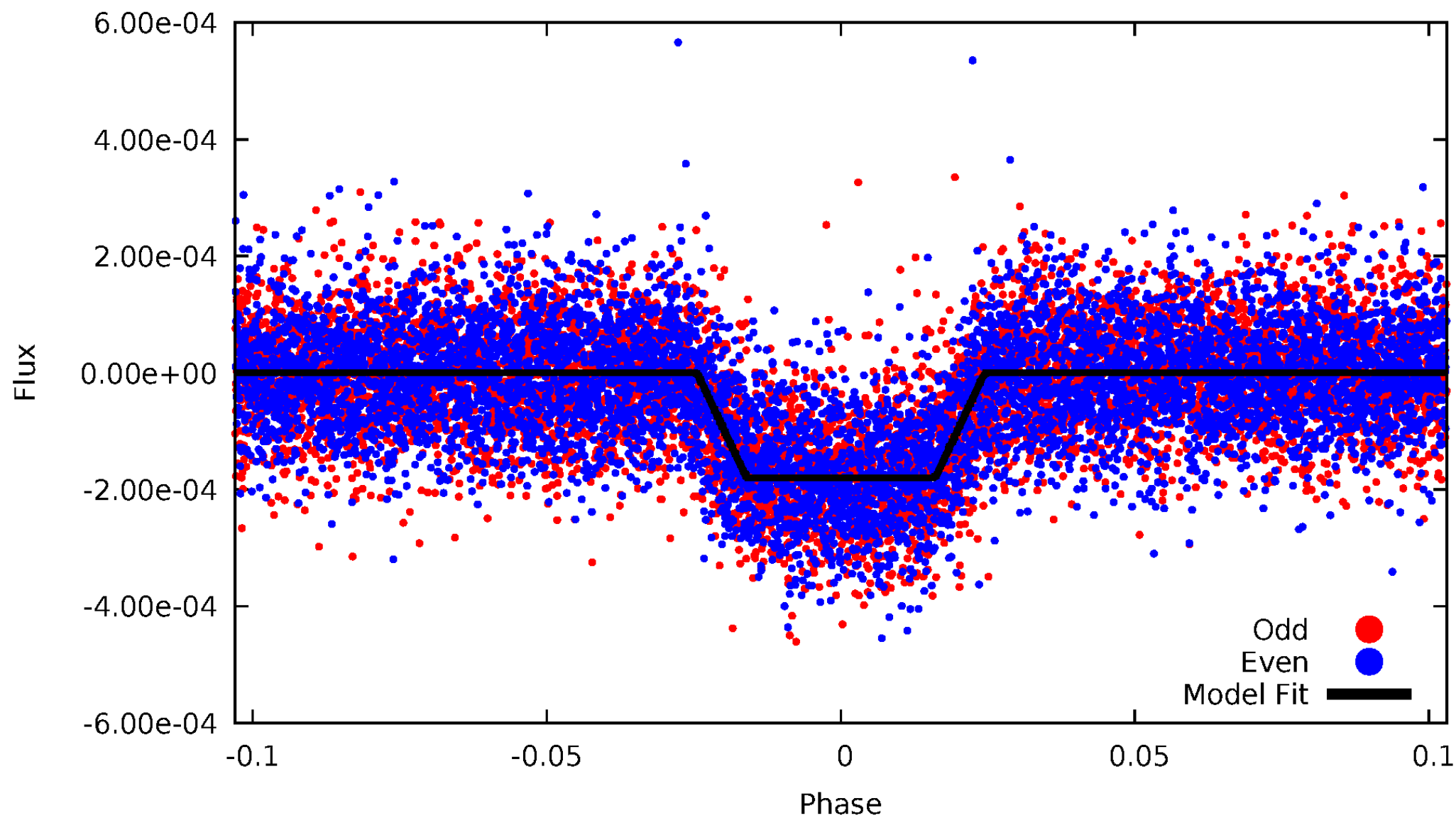
TCE 008753657-01





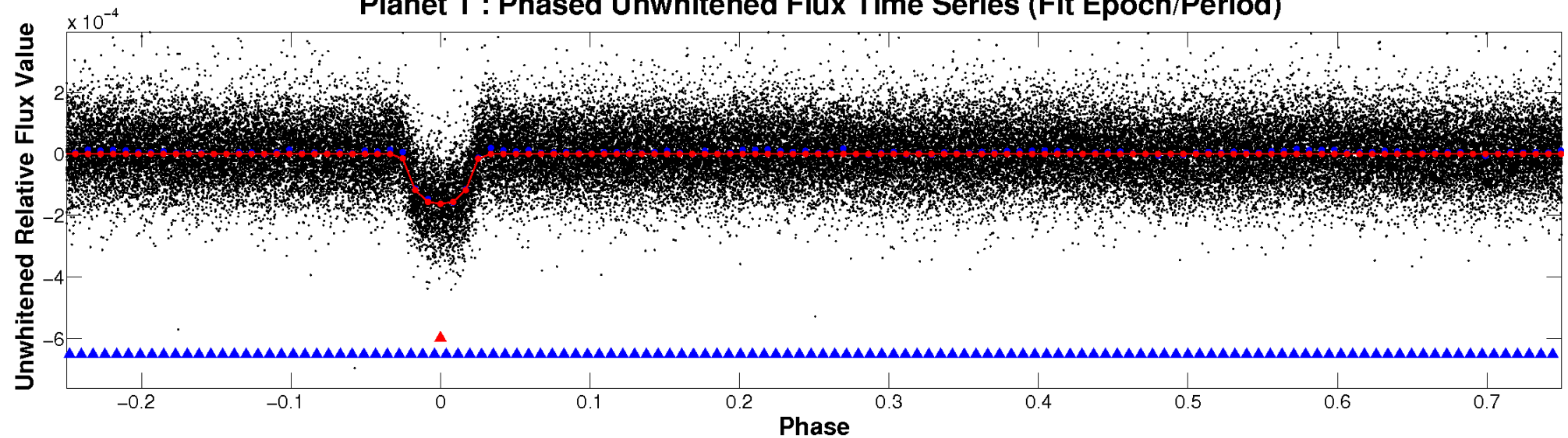
# ALT Odd/Even

TCE 008753657-01

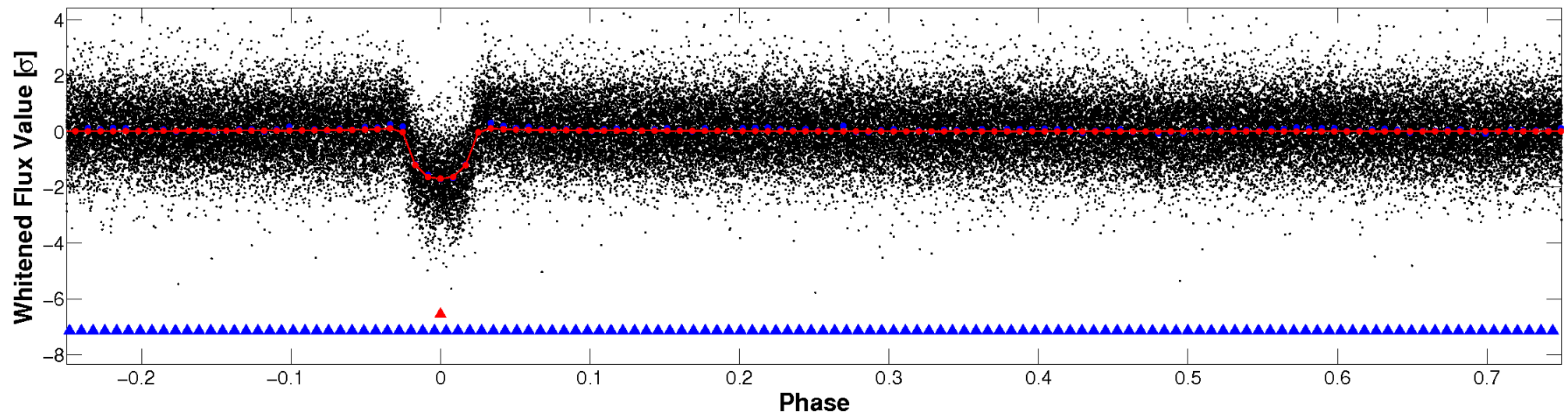


# Non-Whitened Vs. Whitened Light Curve

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

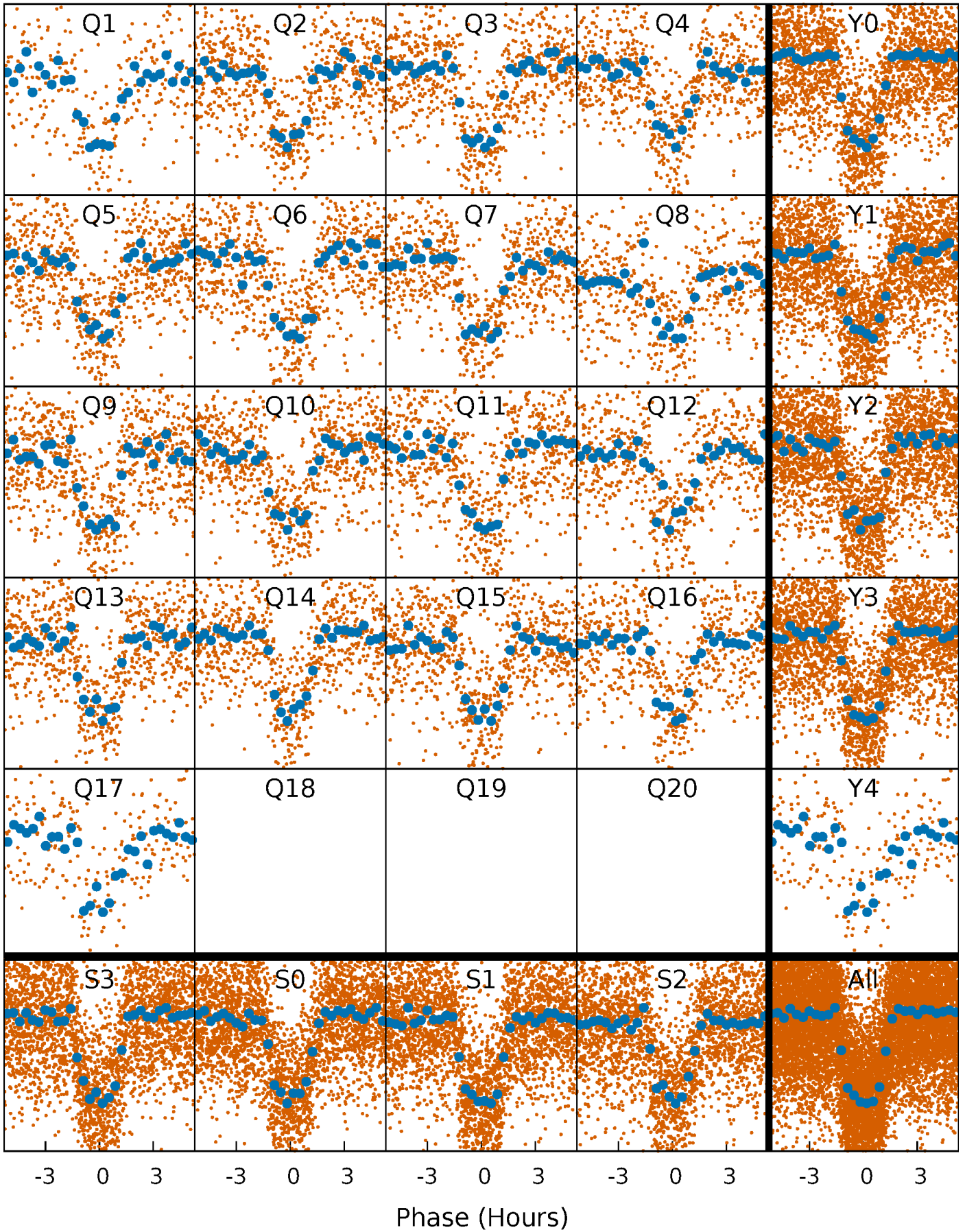


**Planet 1 : Phased Whitened Flux Time Series (Fit Epoch/Period)**



# PDC Quarter-Phased Transit Curves

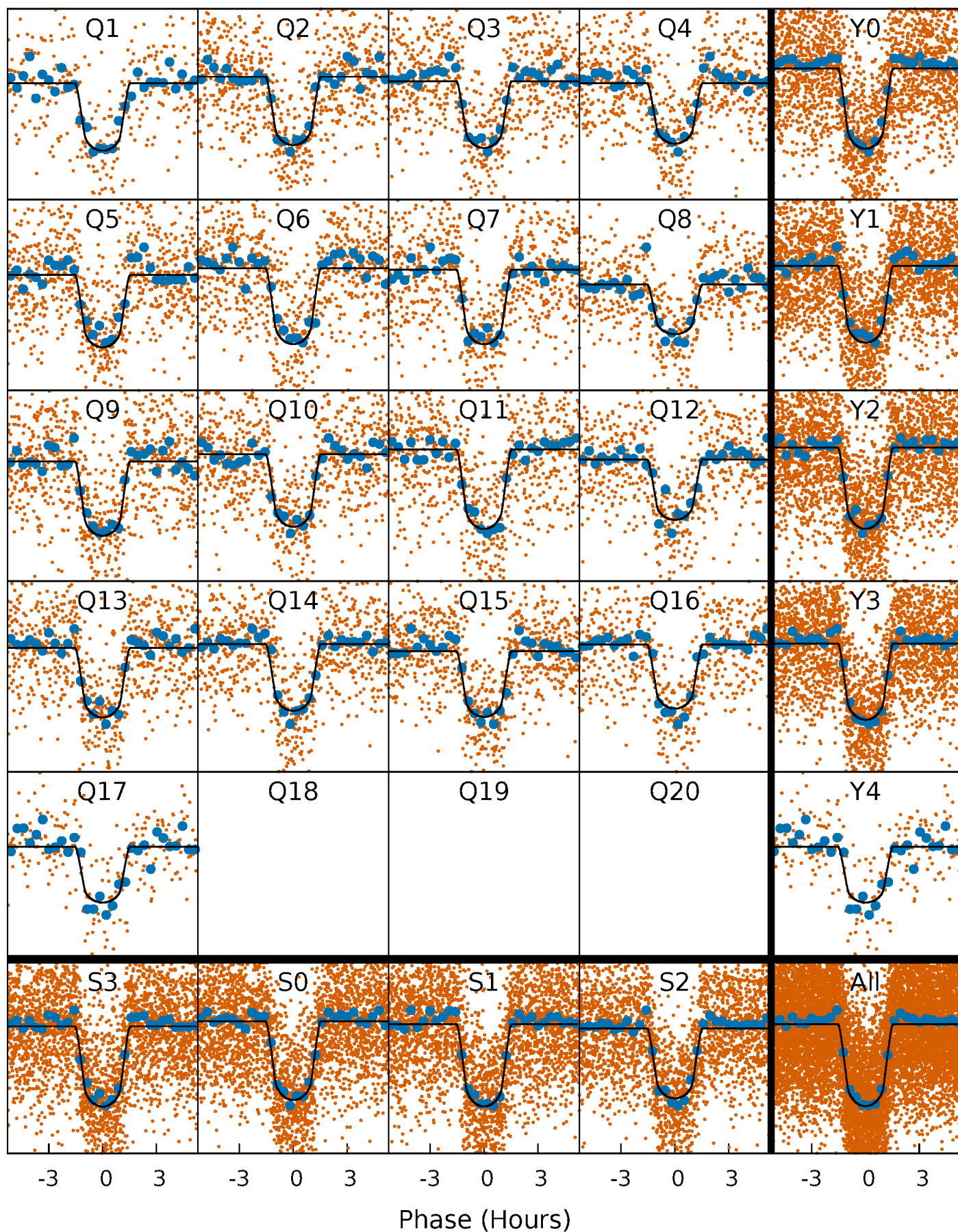
TCE 008753657-01 P= 2.426293 Days  $T_0=131.637238$  (BKJD)





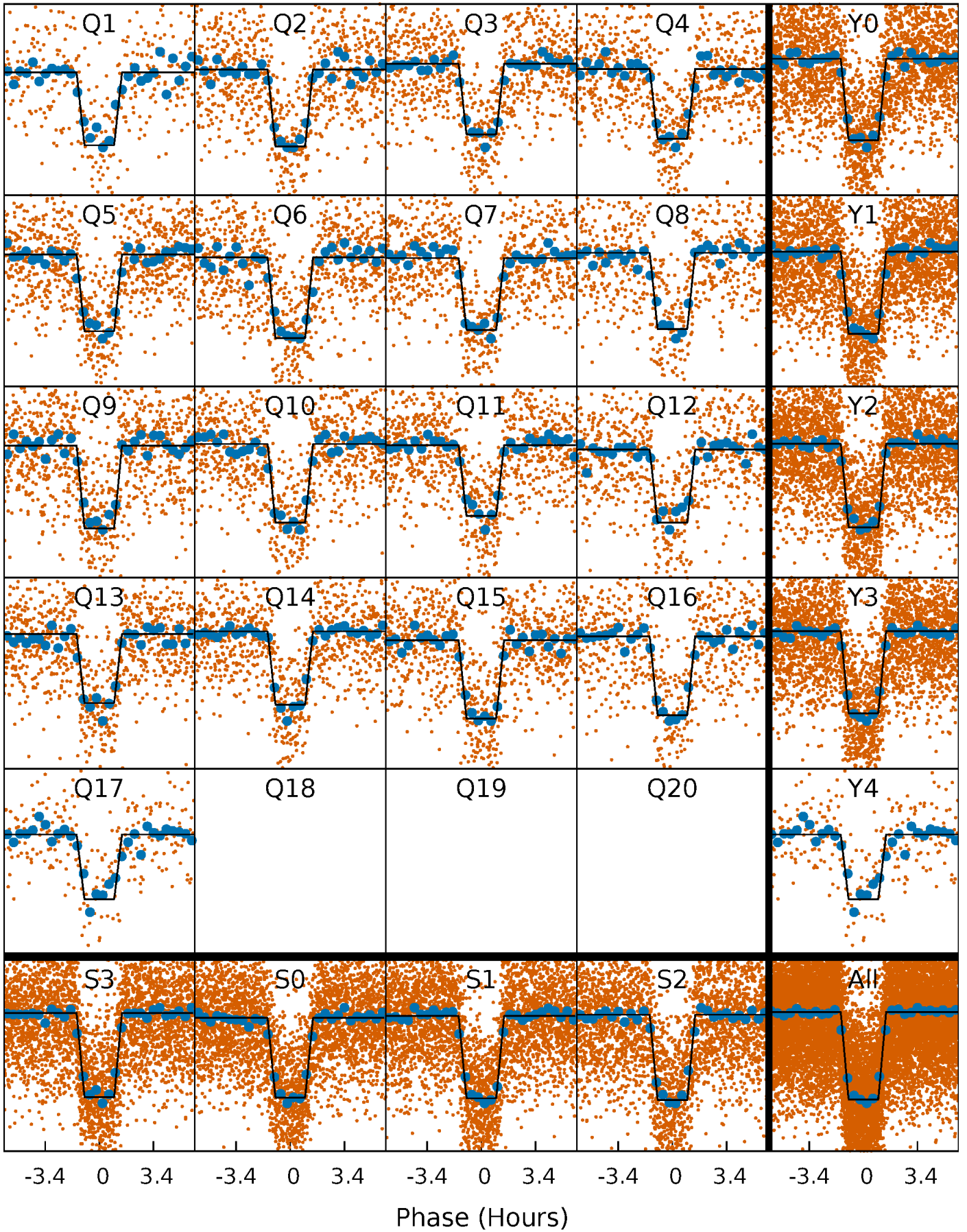
# DV Quarter-Phased Transit Curves

TCE 008753657-01   P= 2.426293 Days    $T_0=131.637238$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

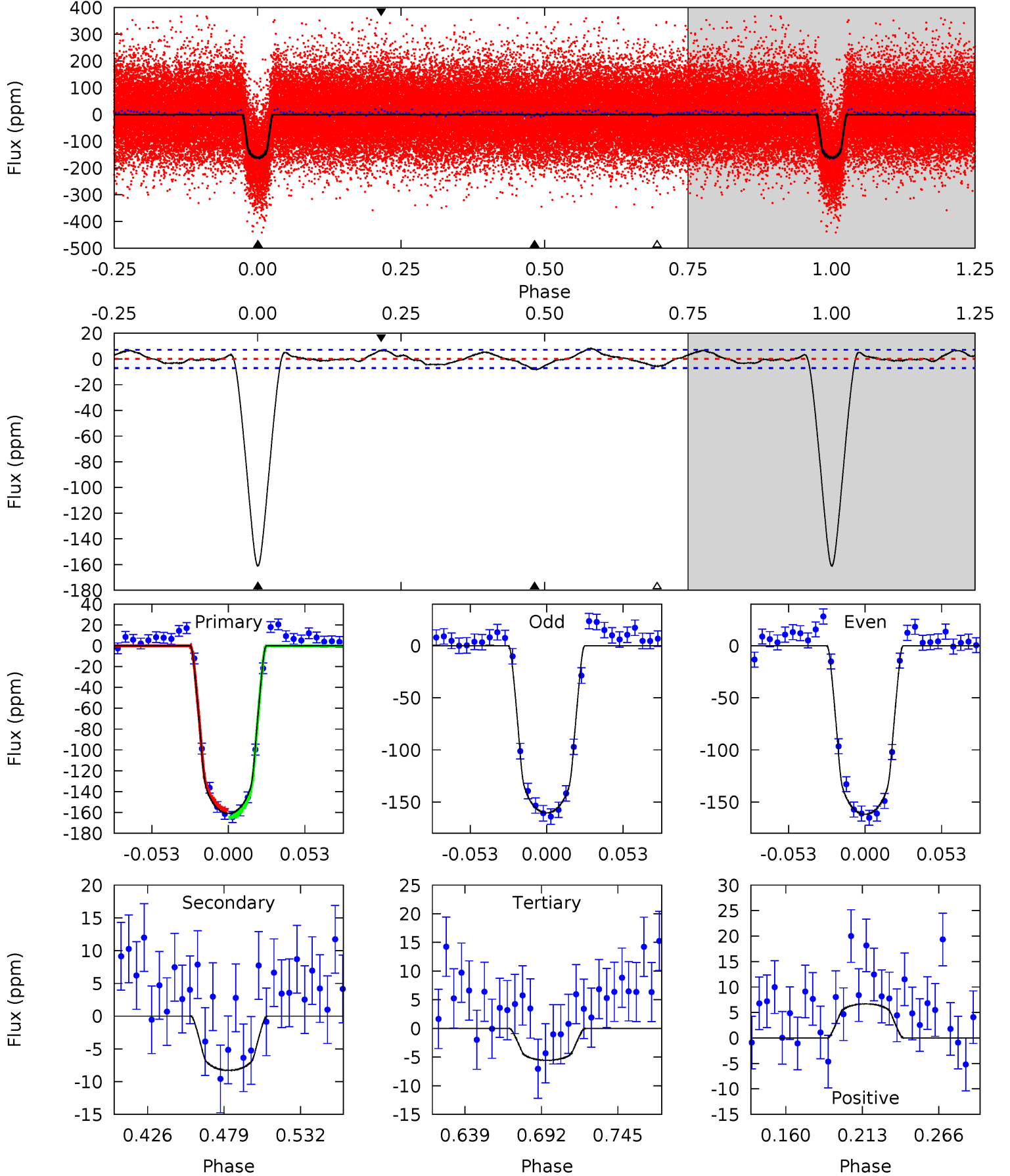
TCE 008753657-01 P= 2.426306 Days  $T_0=131.634078$  (BKJD)



# DV Model-Shift Uniqueness Test

008753657-01, P = 2.426293 Days, E = 129.210945 Days

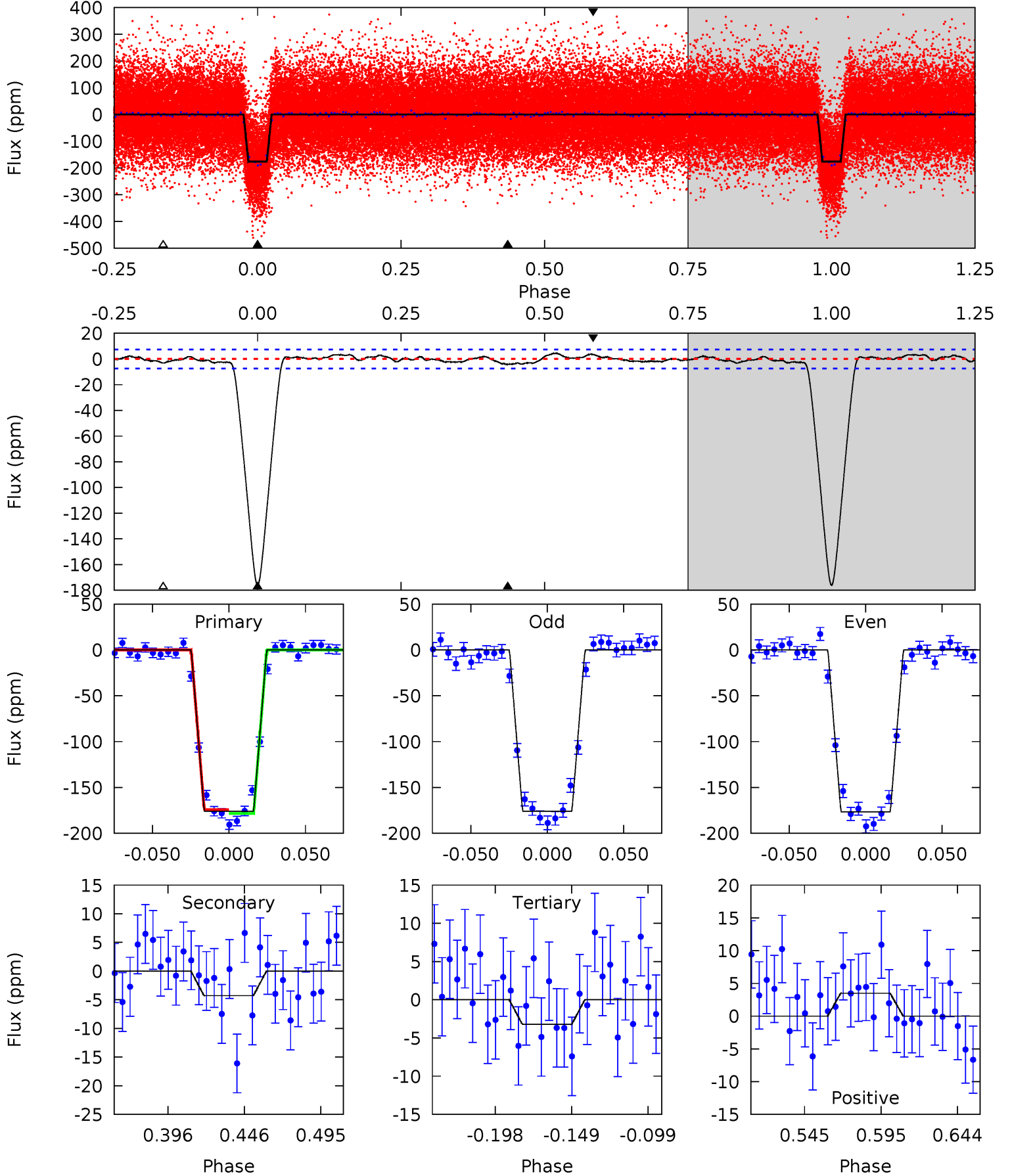
| Pri   | Sec  | Ter  | Pos  | FA <sub>1</sub> | FA <sub>2</sub> | F <sub>Red</sub> | Pri-Ter | Pri-Pos | Sec-Ter | Sec-Pos | Odd-Evn | DMM  | Shape | TAT  |
|-------|------|------|------|-----------------|-----------------|------------------|---------|---------|---------|---------|---------|------|-------|------|
| 106.1 | 5.46 | 3.66 | 4.41 | 4.70            | 1.93            | 2.10             | 102.5   | 101.7   | 1.80    | 1.05    | 0.45    | 0.99 | 0.05  | 2.41 |



# Alt Model-Shift Uniqueness Test

008753657-01, P = 2.426306 Days, E = 129.207772 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  |
|-------|------|------|------|-----------------|-----------------|------------------|---------|---------|---------|---------|---------|------|-------|------|
| 112.1 | 2.73 | 2.05 | 2.23 | 4.71            | 1.96            | 1.11             | 110.1   | 109.9   | 0.68    | 0.50    | 0.25    | 1.00 | 0.02  | 1.35 |





### Stellar Parameters For KIC 008753657

|        | $T_{\text{eff}}(K)$  | $\log(g)$                 | [Fe/H]                    | $R$ ( $R_{\odot}$ )       | $M(M_{\odot})$            | $p_{\star}$ ( $\text{g}\cdot\text{cm}^{-3}$ ) |
|--------|----------------------|---------------------------|---------------------------|---------------------------|---------------------------|---|
|        | $5678^{+102}_{-124}$ | $4.484^{+0.030}_{-0.120}$ | $0.260^{+0.150}_{-0.150}$ | $0.970^{+0.150}_{-0.053}$ | $1.043^{+0.044}_{-0.076}$ | $1.613^{+0.240}_{-0.550}$                     |
|        | +2%/-2%              | +1%/-3%                   | +58%/-58%                 | +15%/-5%                  | +4%/-7%                   | +15%/-34%                                     |
| Source | SPE59                | SPE59                     | SPE59                     | DSEP                      |                           |   |

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

### Secondary Eclipse Parameters for KIC 008753657-01 / KOI 0321.01

| Detrend | Depth (ppm) | $R_p$ ( $R_{\oplus}$ ) | $T_{\text{max}}$ (K) | $T_{\text{obs}}$ (K) | $A_{\text{obs}}$          |
|---------|-------------|------------------------|----------------------|----------------------|---------------------------|
| DV      | $-8 \pm 2$  | $1.52^{+0.16}_{-0.17}$ | $1838^{+71}_{-56}$   | $3107^{+140}_{-133}$ | $2.478^{+0.830}_{-0.602}$ |
| Alt.    | $-4 \pm 2$  | $1.45^{+0.17}_{-0.16}$ | $1839^{+69}_{-53}$   | $2817^{+197}_{-219}$ | $1.386^{+0.679}_{-0.520}$ |

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



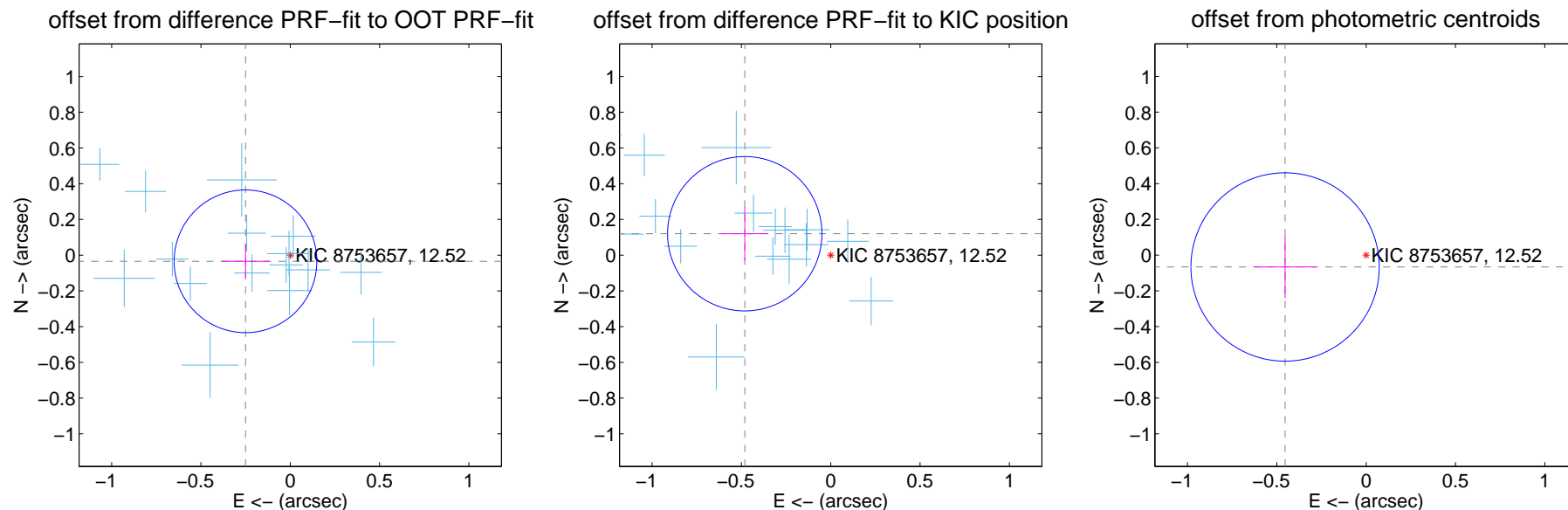
## DV Centroid Data

Supplemental centroid analysis for 008753657-01. Kepler magnitude: 12.52. Transit SNR 76.20

There are 17 quarters with good PRF difference image offsets

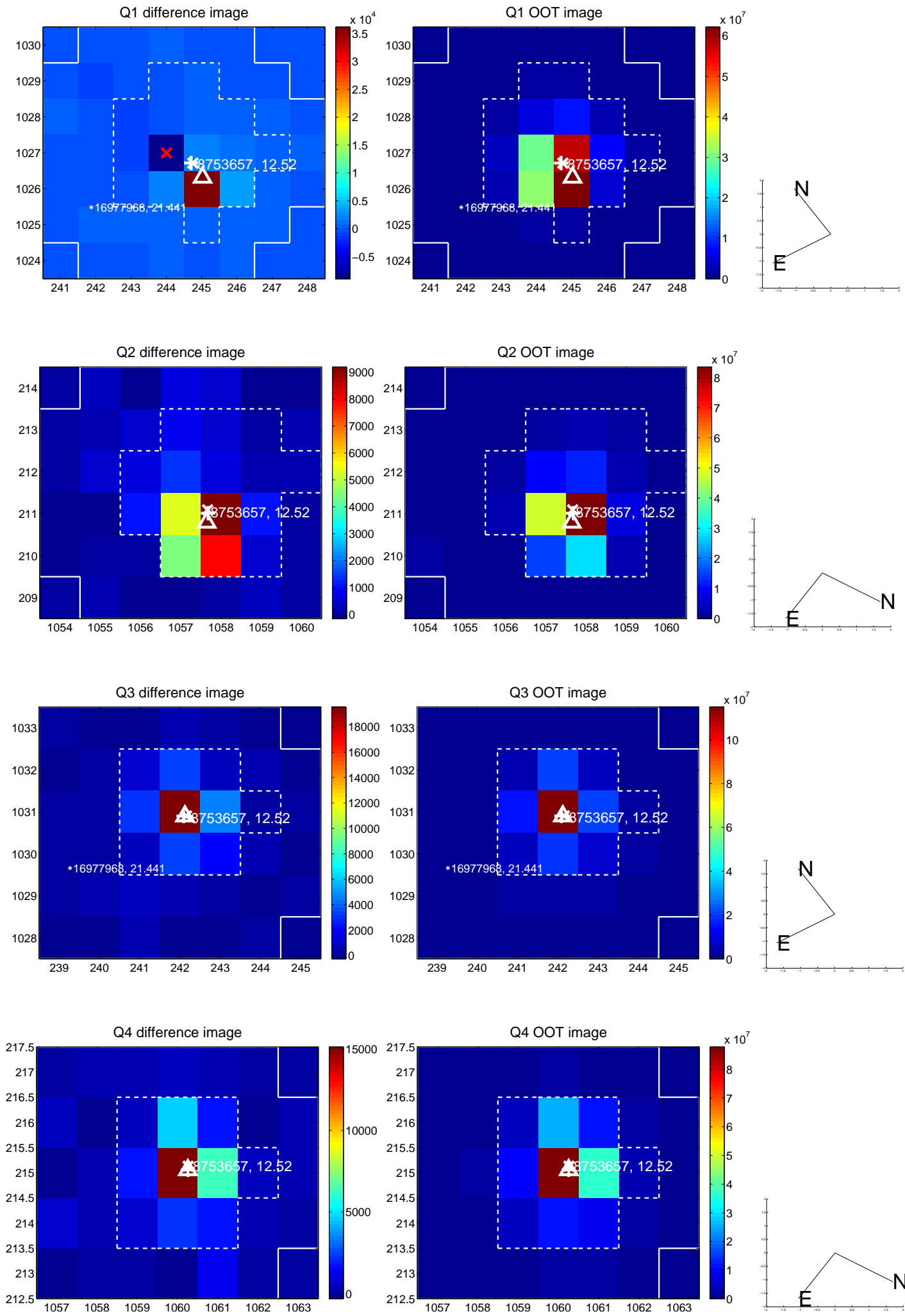
The direct PRF centroid is offset from the target star catalog position by about 0.31 arcsec

|   | Distance in arcsec                  | Distance / $\sigma$ | $\Delta$ RA       | $\Delta$ Dec       |
|---|-------------------------------------|---------------------|-------------------|--------------------|
| PRF-fit source offset from OOT          | $0.253 \pm 0.133$                   | 1.90                | $0.251 \pm 0.134$ | $-0.034 \pm 0.095$ |
| PRF-fit source offset from KIC position | <b><math>0.496 \pm 0.144</math></b> | <b>3.44</b>         | $0.481 \pm 0.131$ | $0.120 \pm 0.150$  |
| photometric centroid source offset      | $0.46 \pm 0.18$                     | 2.61                | $0.45 \pm 0.18$   | $-0.07 \pm 0.18$   |

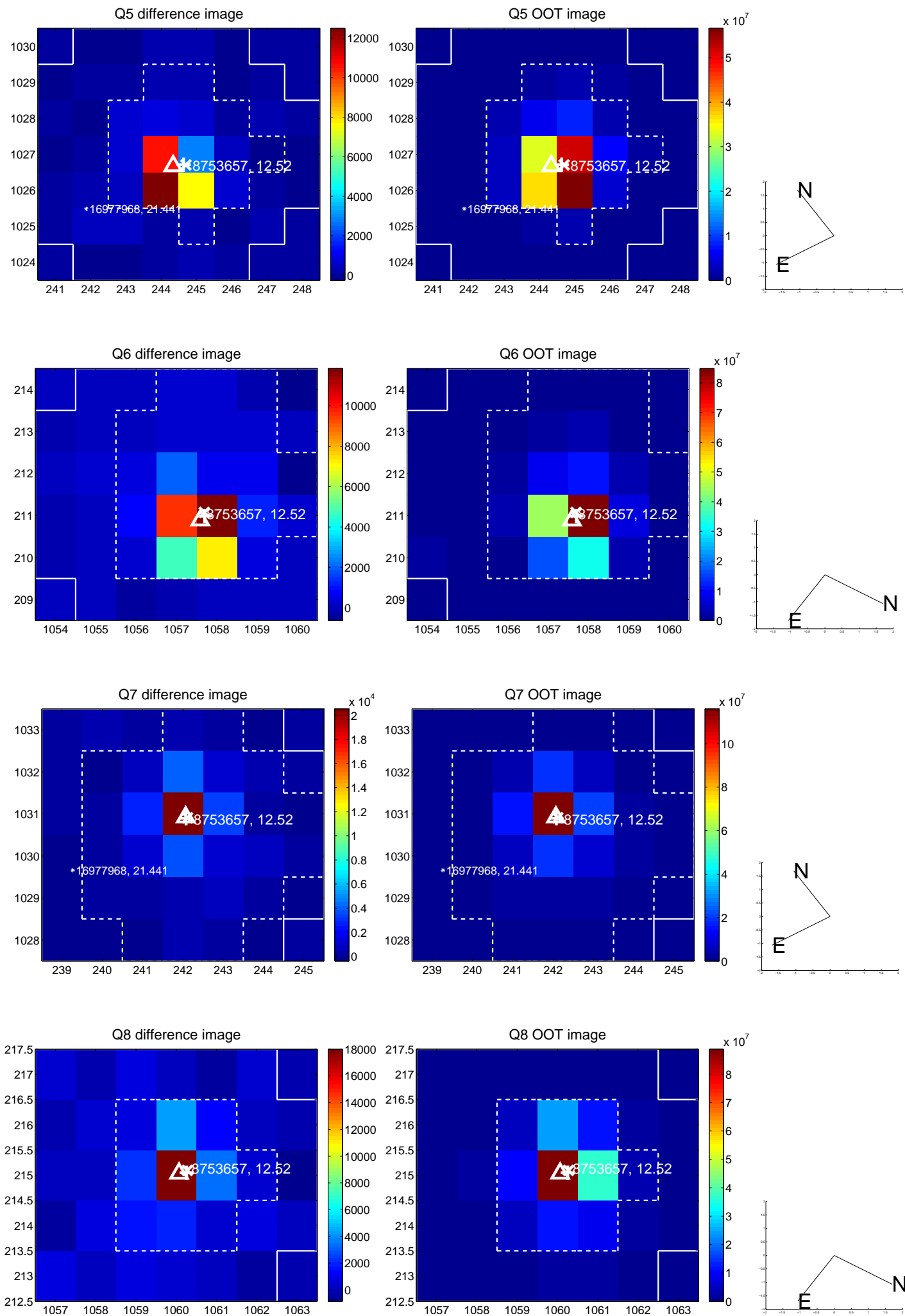


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: three-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

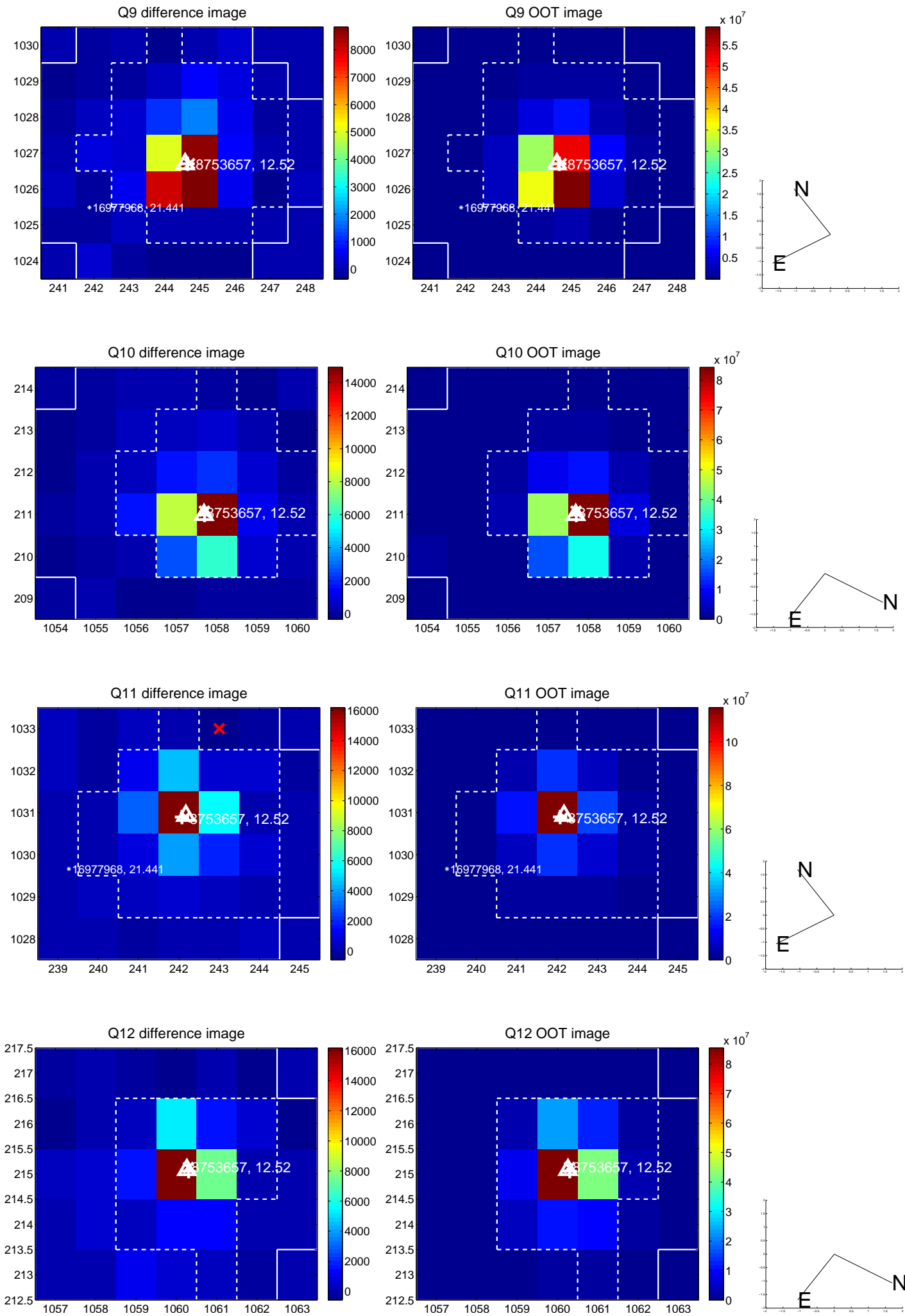
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



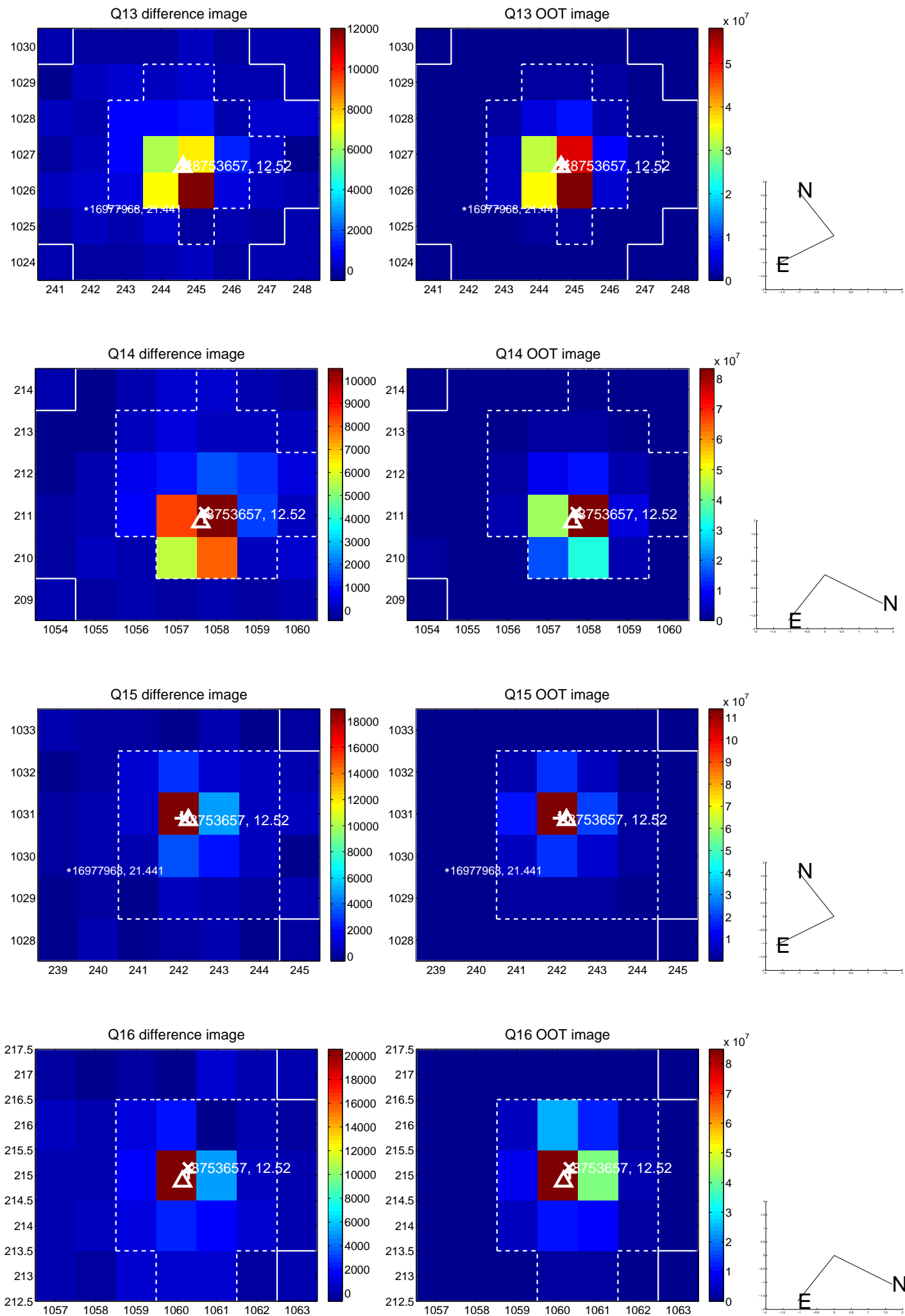
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

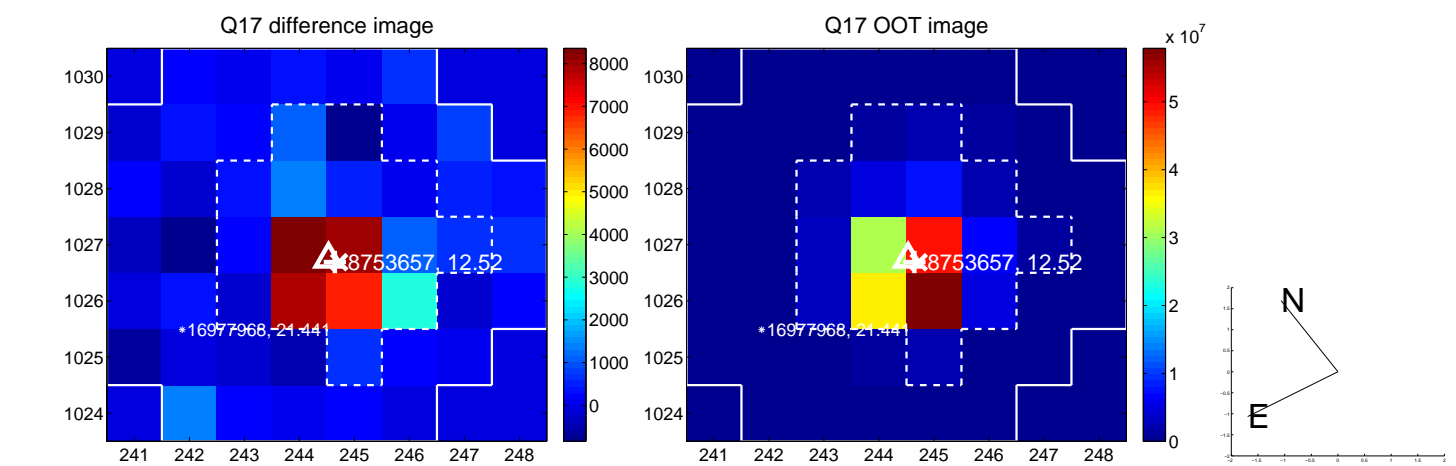


white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

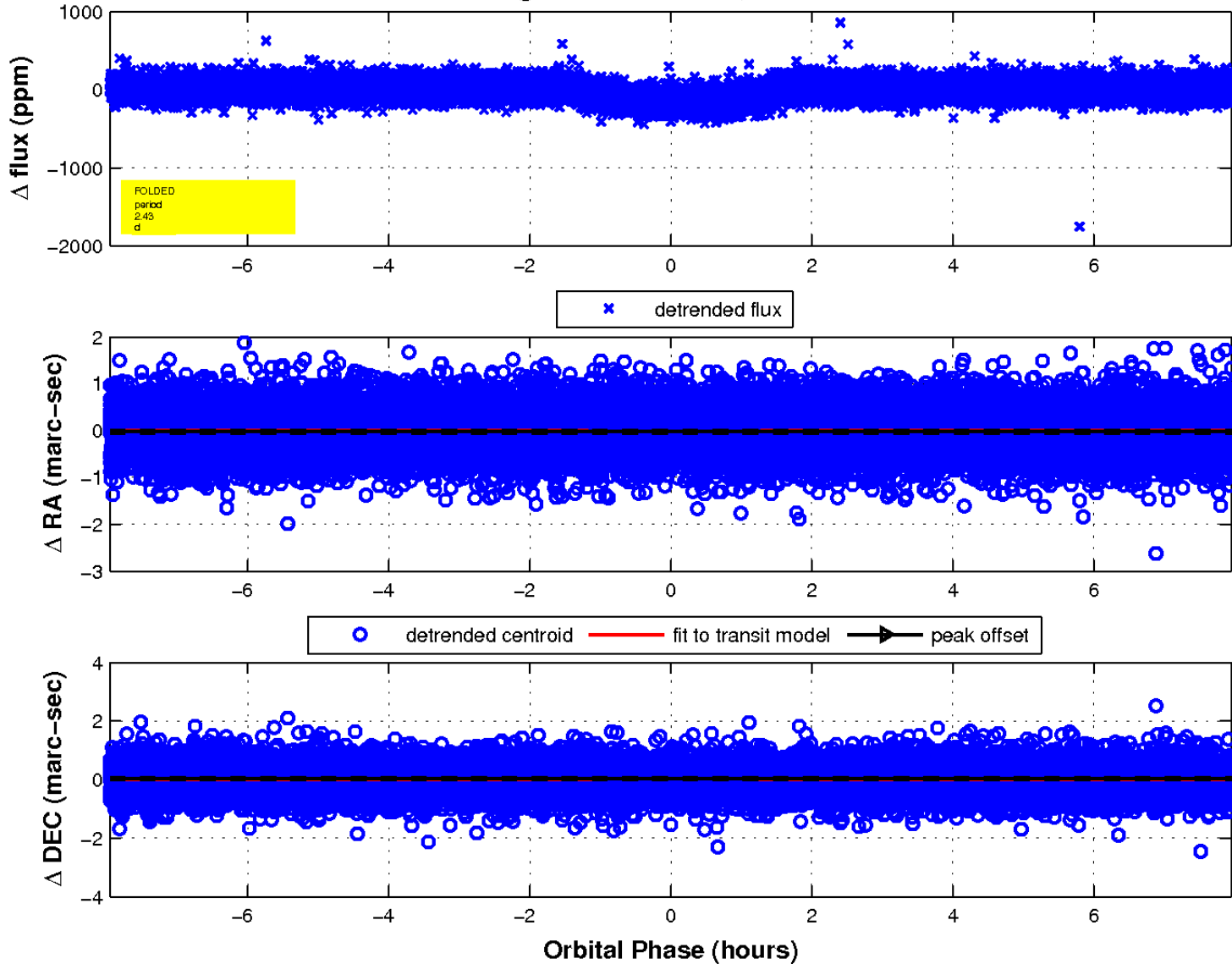




white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

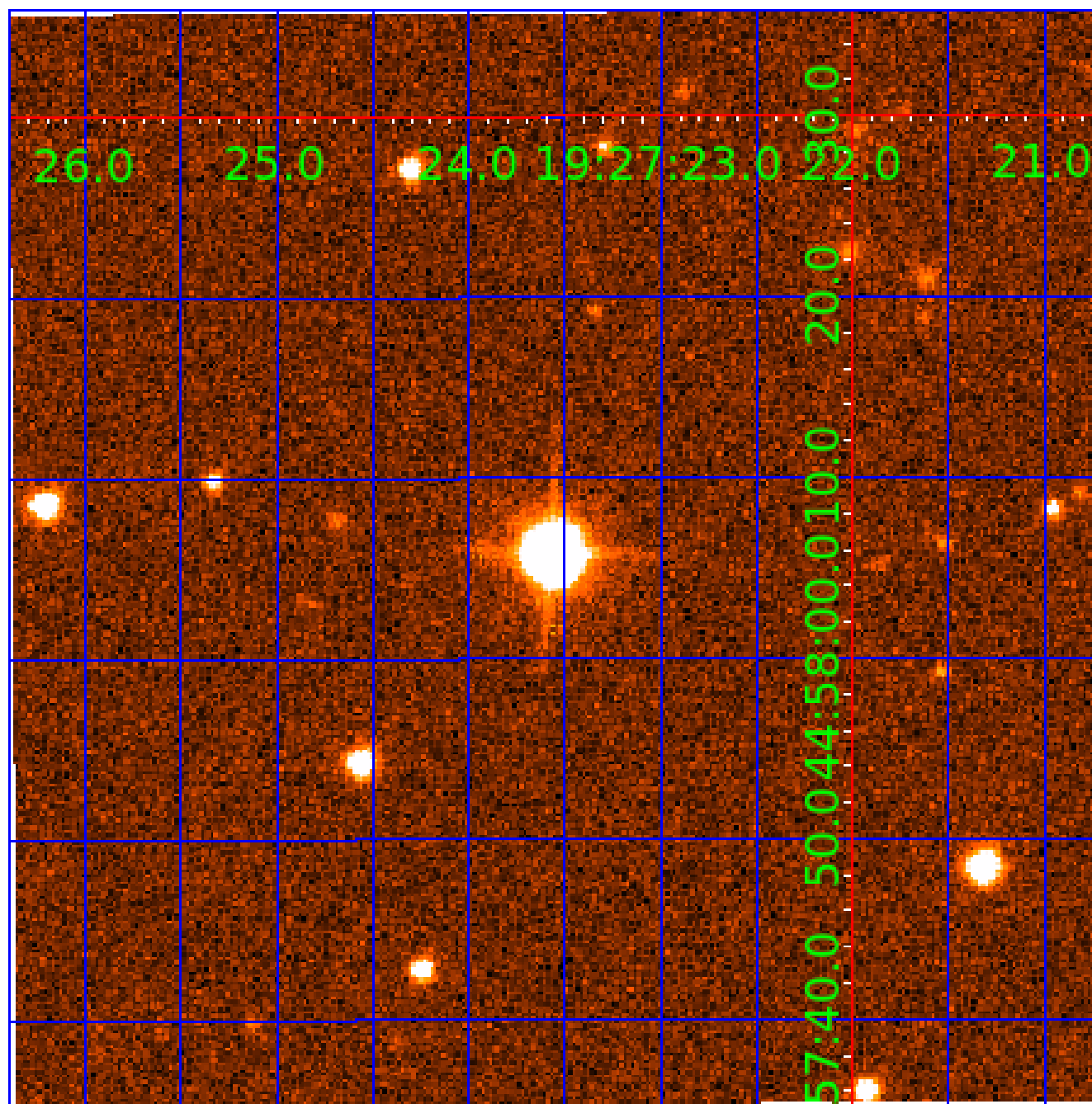


fluxWeightedCentroids, Planet 1 of 2



UKIRT Image

Declination



# KIC 008753657

## 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) | $R_p$ ( $R_{\oplus}$ ) | $S_p$ ( $S_{\oplus}$ ) |
|--------------|----------|---------|---------------|--------------|-------------|------------------|------|------|-----------------------------|-----------------|------------------------|------------------------|
| 008753657-01 | OBS      | 0321.01 | 2.426293      | 131.637238   | 162.6       | 2.652            | 65.8 | 76.2 | 0.97                        | 5678            | 1.48                   | 680.66                 |
| 008753657-02 | OBS      | 0321.02 | 4.623327      | 132.372896   | 63.2        | 3.006            | 20.6 | 22.0 | 0.97                        | 5678            | 0.91                   | 288.13                 |

## Robovetter Results

| TCE          | Run Type | Disp | Score | N | S | C | E | Comments   |
|--------------|----------|------|-------|---|---|---|---|------------|
| 008753657-01 | OBS      | PC   | 1.00  | 0 | 0 | 0 | 0 | NO_COMMENT |
| 008753657-02 | OBS      | PC   | 1.00  | 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.

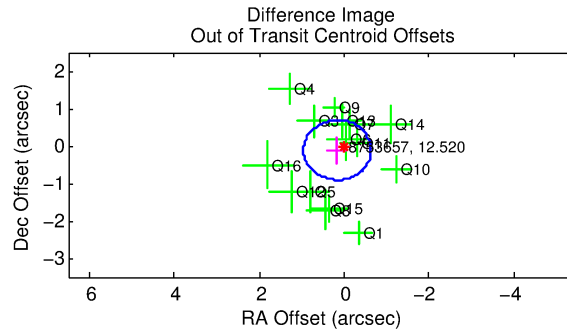
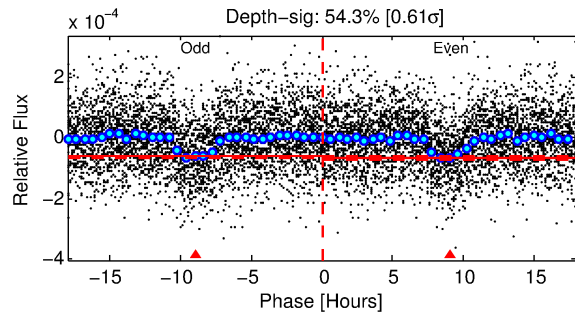
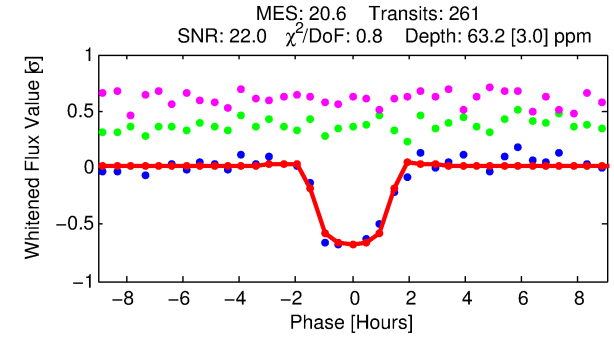
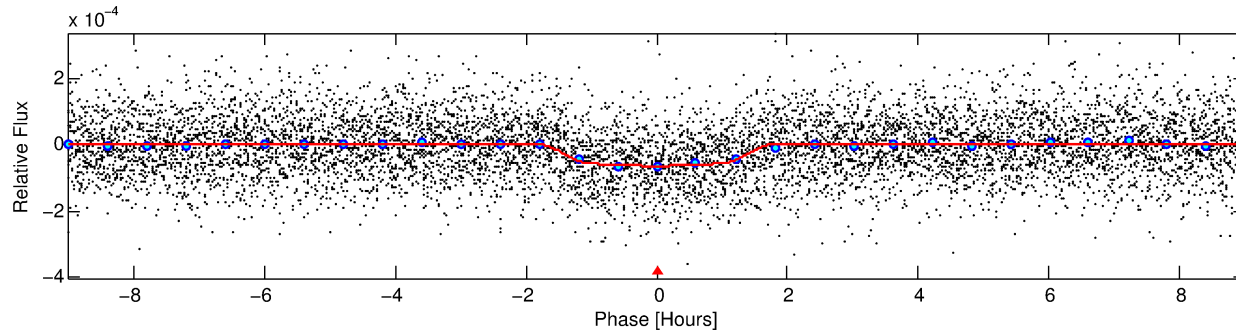
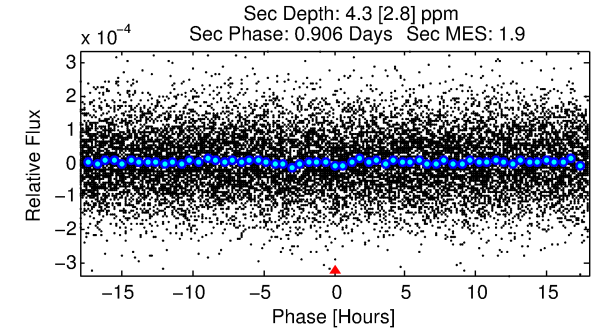
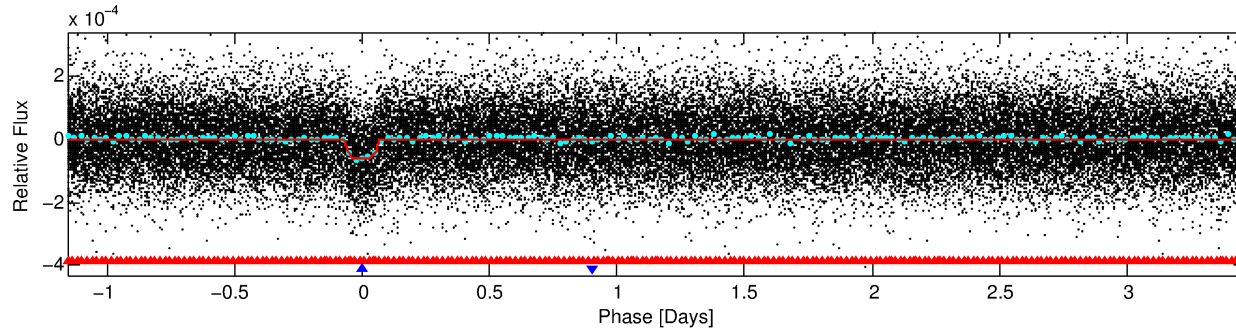
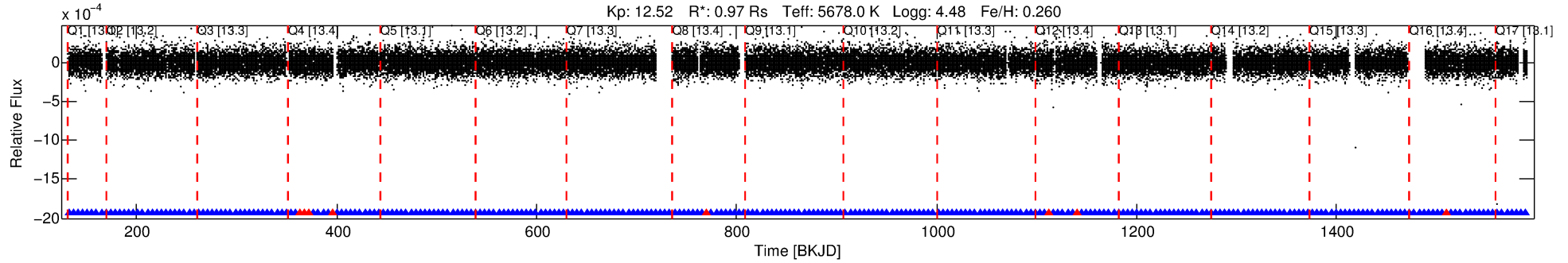
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 008753657-02

No Significant Match Found

# DV One-Page Summary

KIC: 8753657 Candidate: 2 of 2 Period: 4.623 d  
KOI: K00321.02 Name: Kepler-406c Corr: 0.993



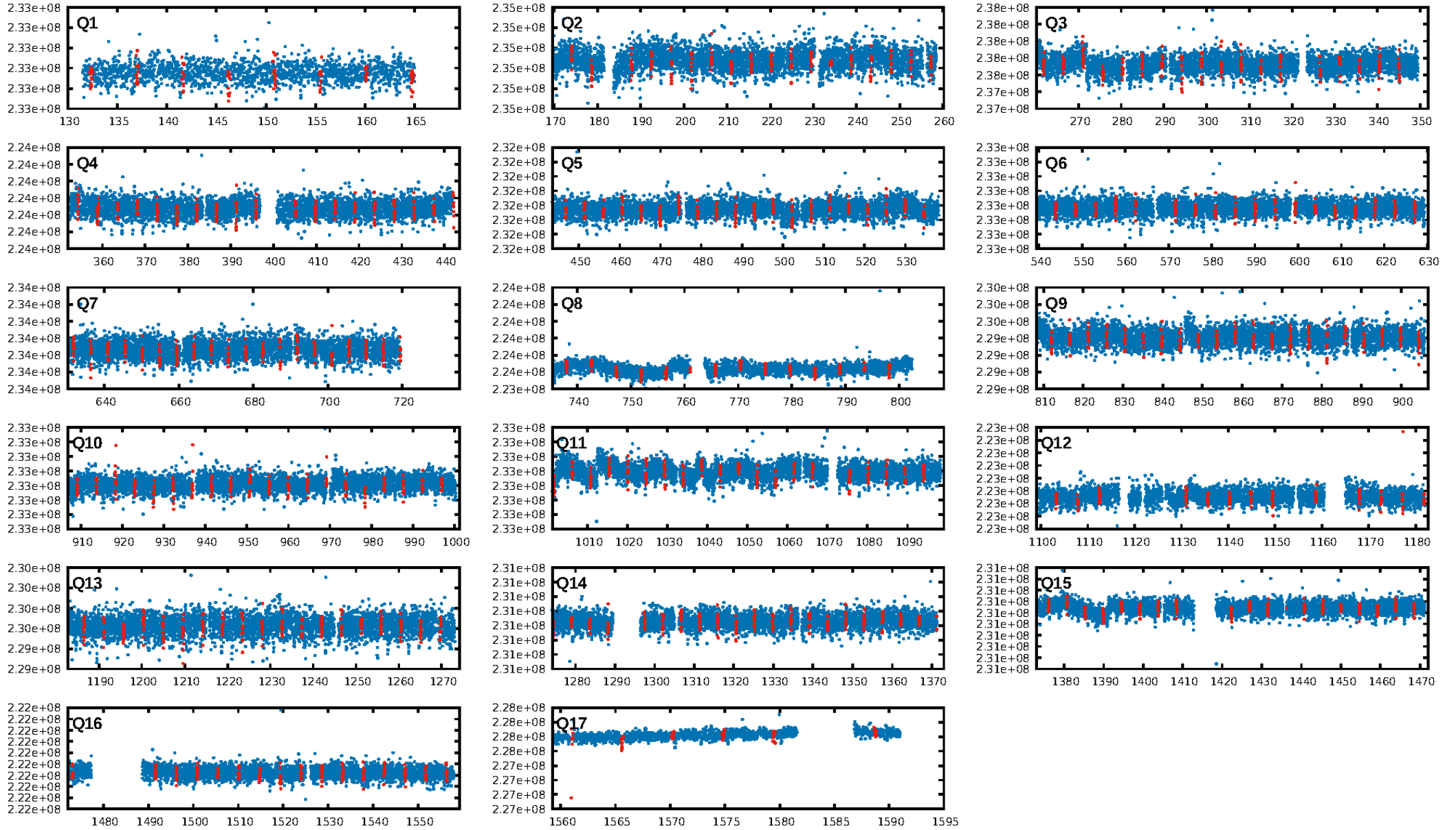
## DV Fit Results:

Period = 4.62333 [0.00002] d  
Epoch = 132.3729 [0.0024] BKJD  
Rp/R\* = 0.0086 [0.0027]  
a/R\* = 5.74 [7.94]  
b = 0.89 [0.35]  
Seff = 288.13 [65.82]  
Teq = 1051 [60] K  
Rp = 0.91 [0.32] Re  
a = 0.0551 [0.0076] AU  
Ag = 8.63 [8.12] [0.94σ]  
Teffp = 2784 [641] K [2.69σ]

## DV Diagnostic Results:

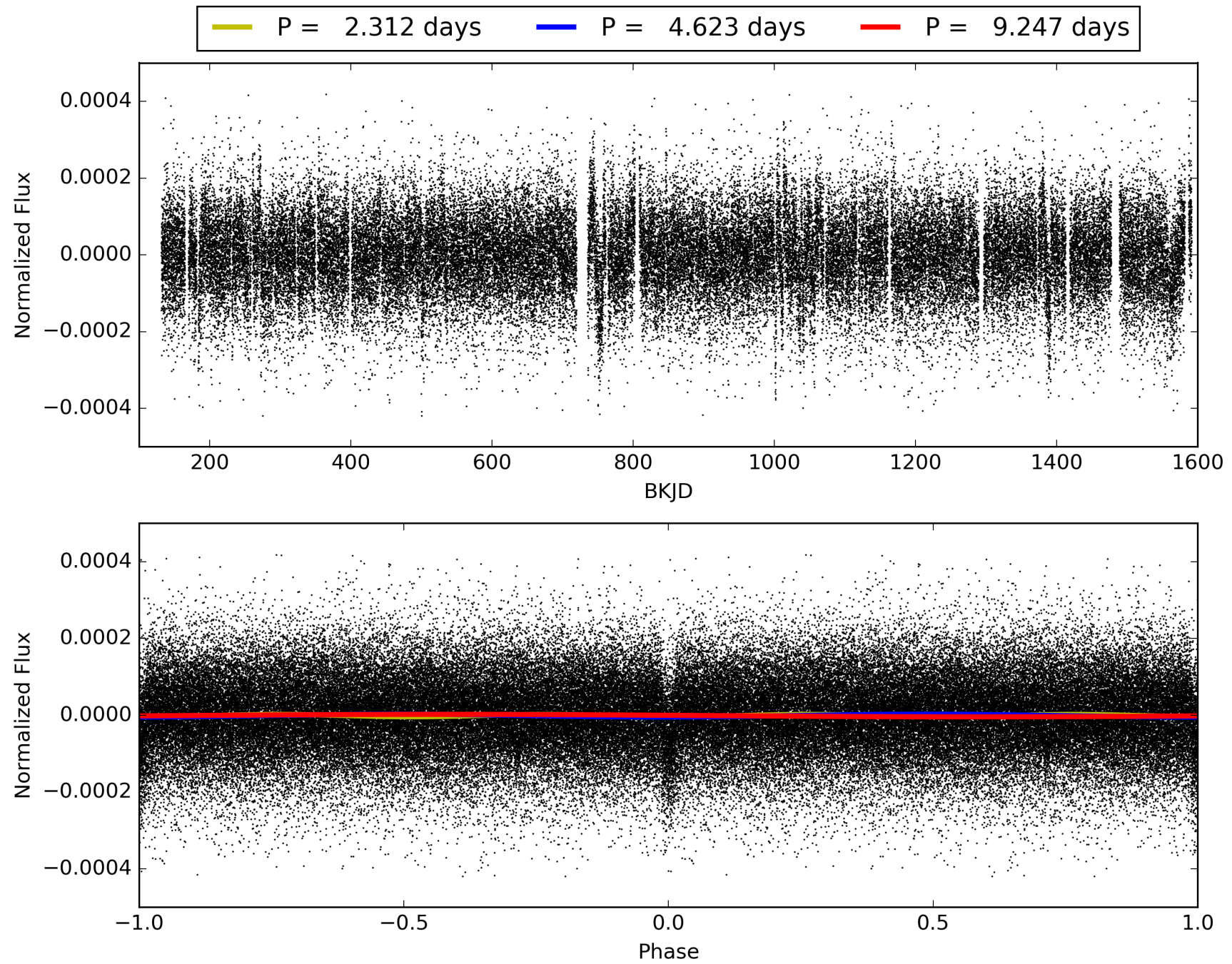
ShortPeriod-sig: 100.0% [13.15σ]  
LongPeriod-sig: N/A  
ModelChiSquare2-sig: N/A  
ModelChiSquareGof-sig: N/A  
Bootstrap-pfa: 4.66e-89  
RollingBand-fgt: 0.97 [241/249]  
GhostDiagnostic-chr: 4.755  
Centroid-sig: 9.6%  
Centroid-so: 0.940 arcsec [1.61σ]  
OotOffset-rm: 0.191 arcsec [0.72σ]  
KicOffset-rm: 0.377 arcsec [1.62σ]  
OotOffset-st: 3/4/4/4 [15]  
KicOffset-st: 3/4/4/4 [15]  
DiffImageQuality-fgm: 1.00 [15/15]  
DiffImageOverlap-fno: 1.00 [17/17]

# TCE 008753657-02, PDC Light Curves



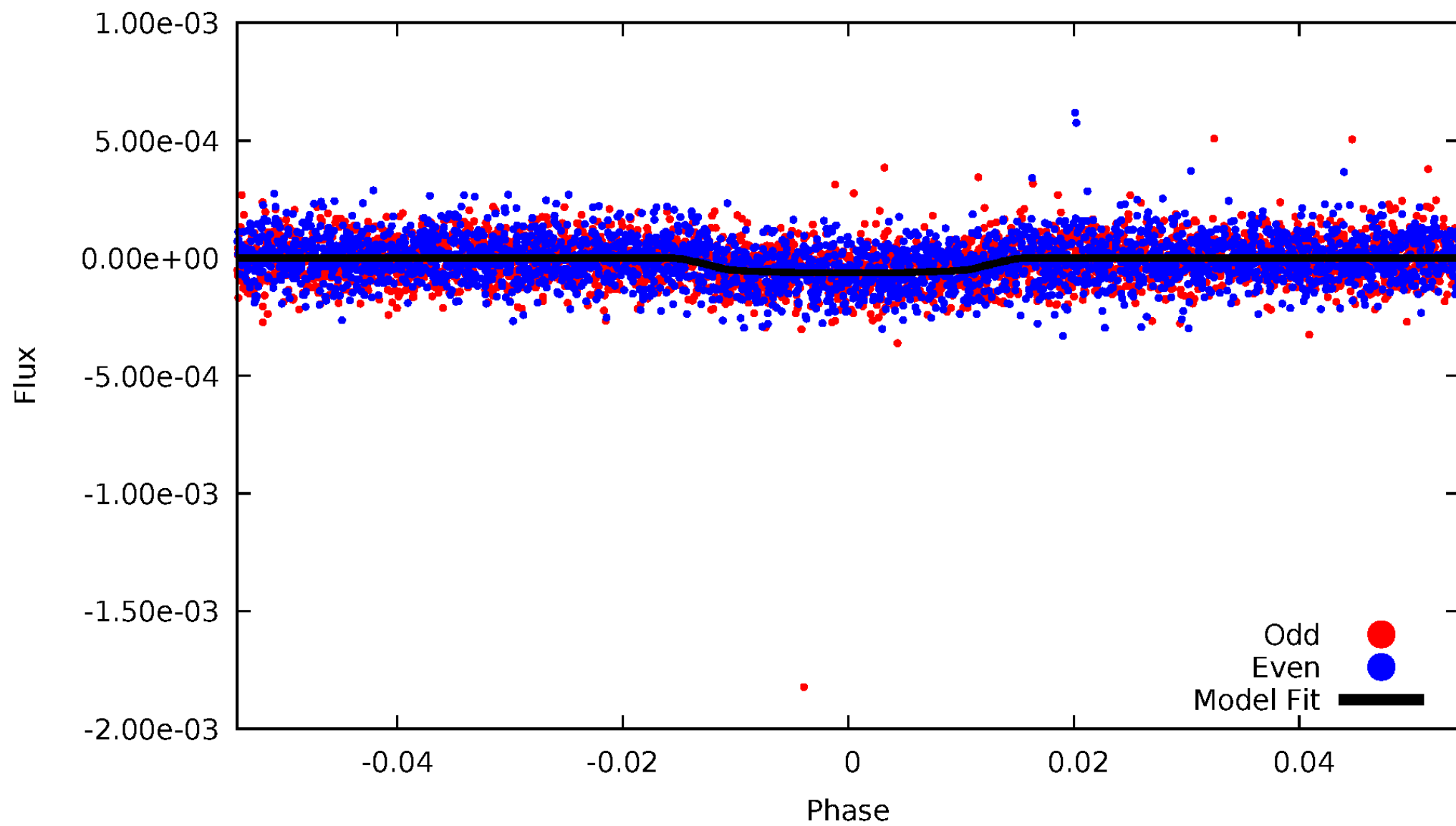


TCE 008753657-02



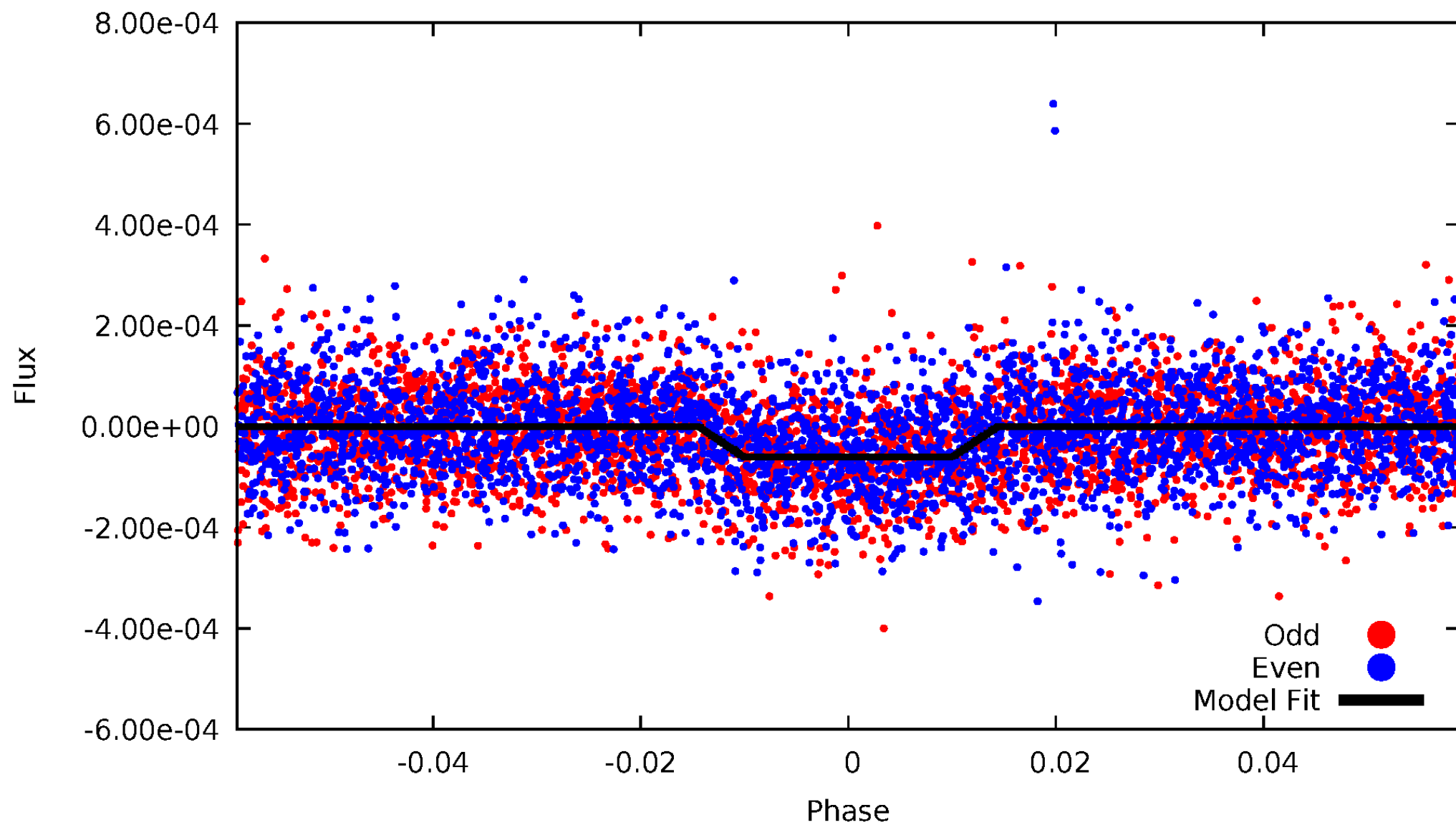
DV Odd/Even

TCE 008753657-02



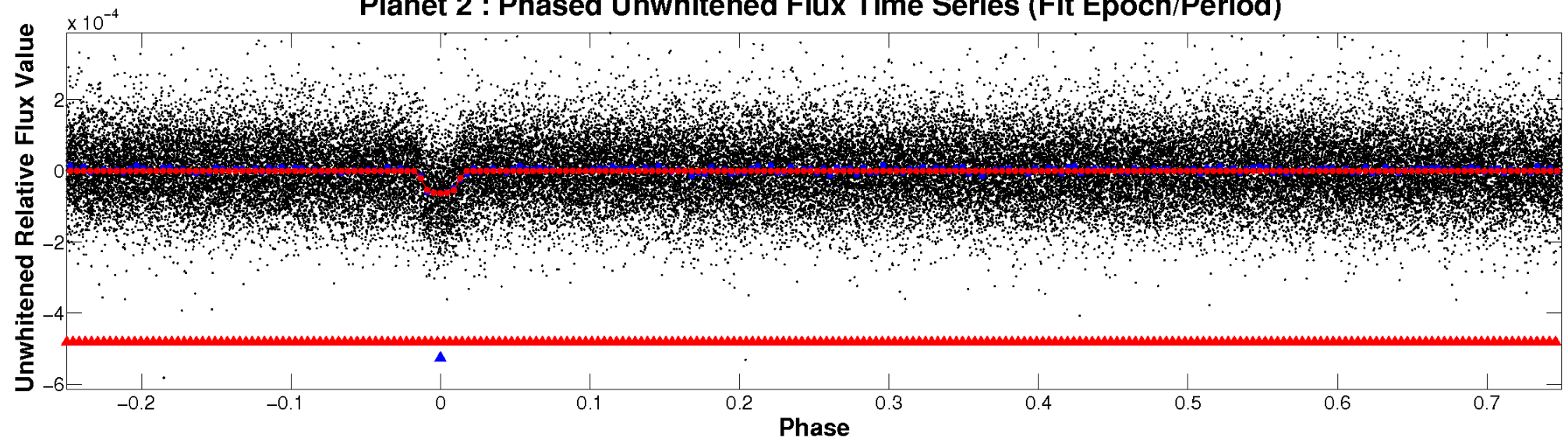
# ALT Odd/Even

TCE 008753657-02

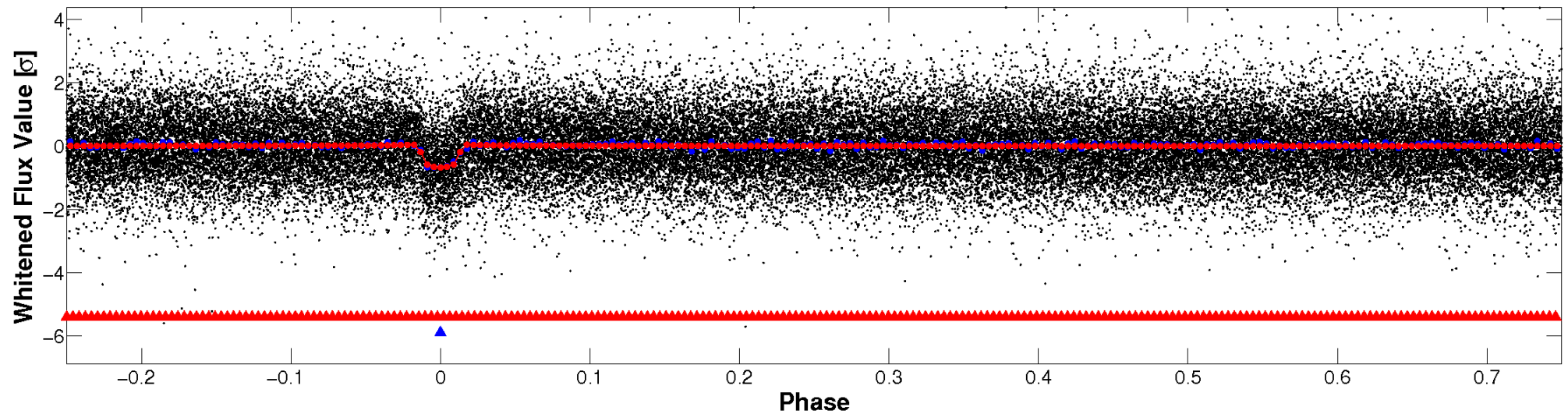


# Non-Whitened Vs. Whitened Light Curve

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



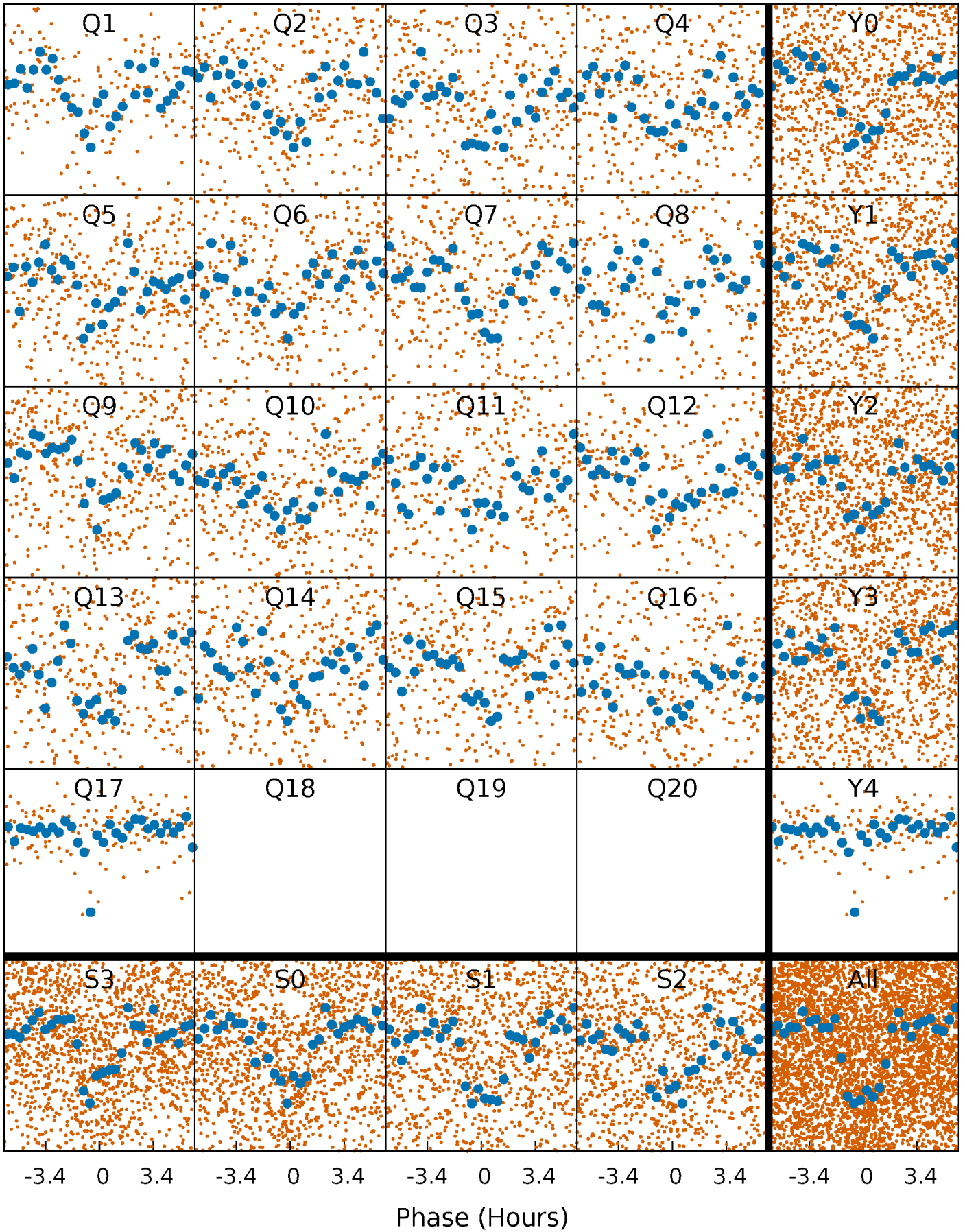
## Planet 2 : Phased Whitened Flux Time Series (Fit Epoch/Period)





# PDC Quarter-Phased Transit Curves

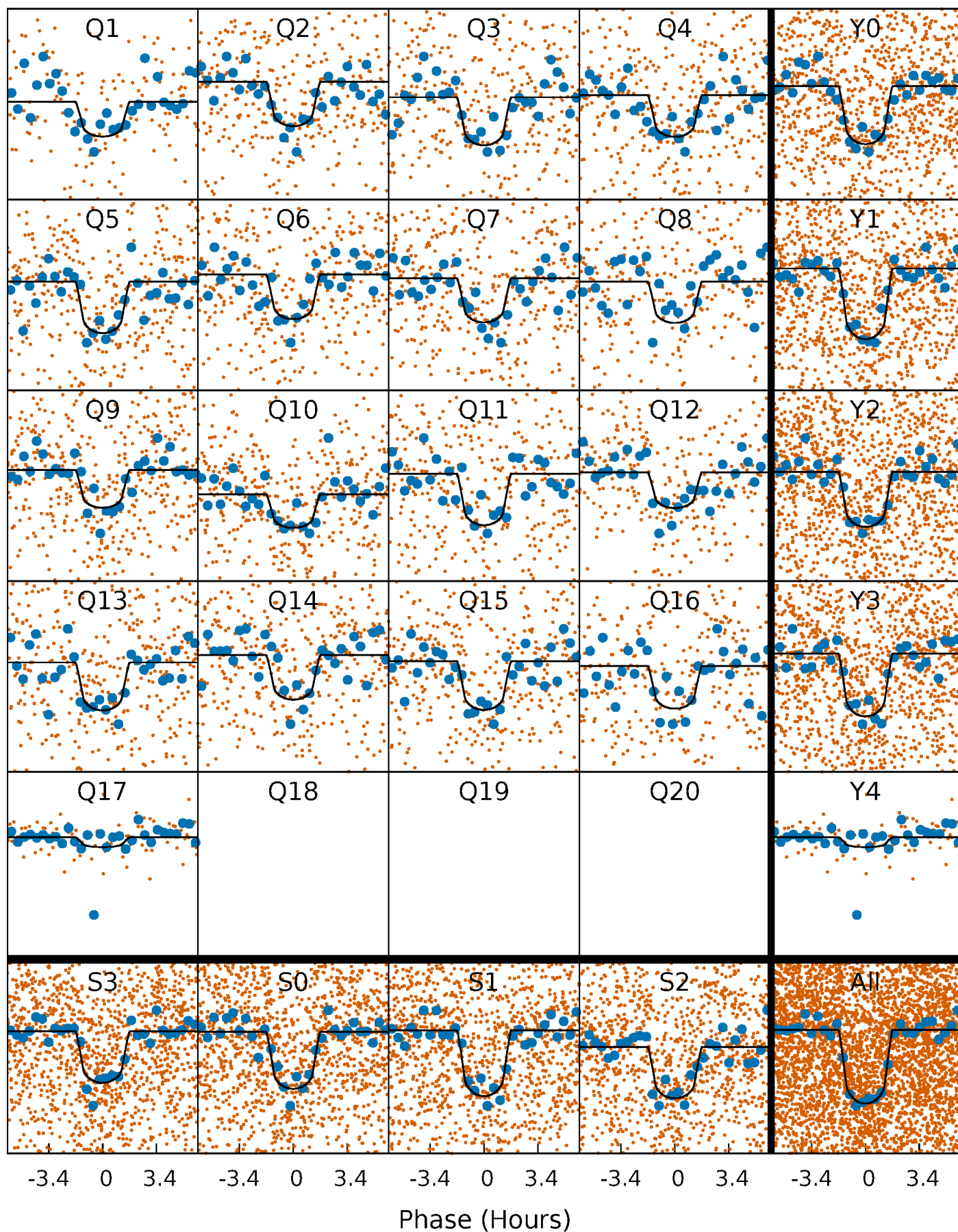
TCE 008753657-02   P= 4.623327 Days    $T_0=132.372896$  (BKJD)





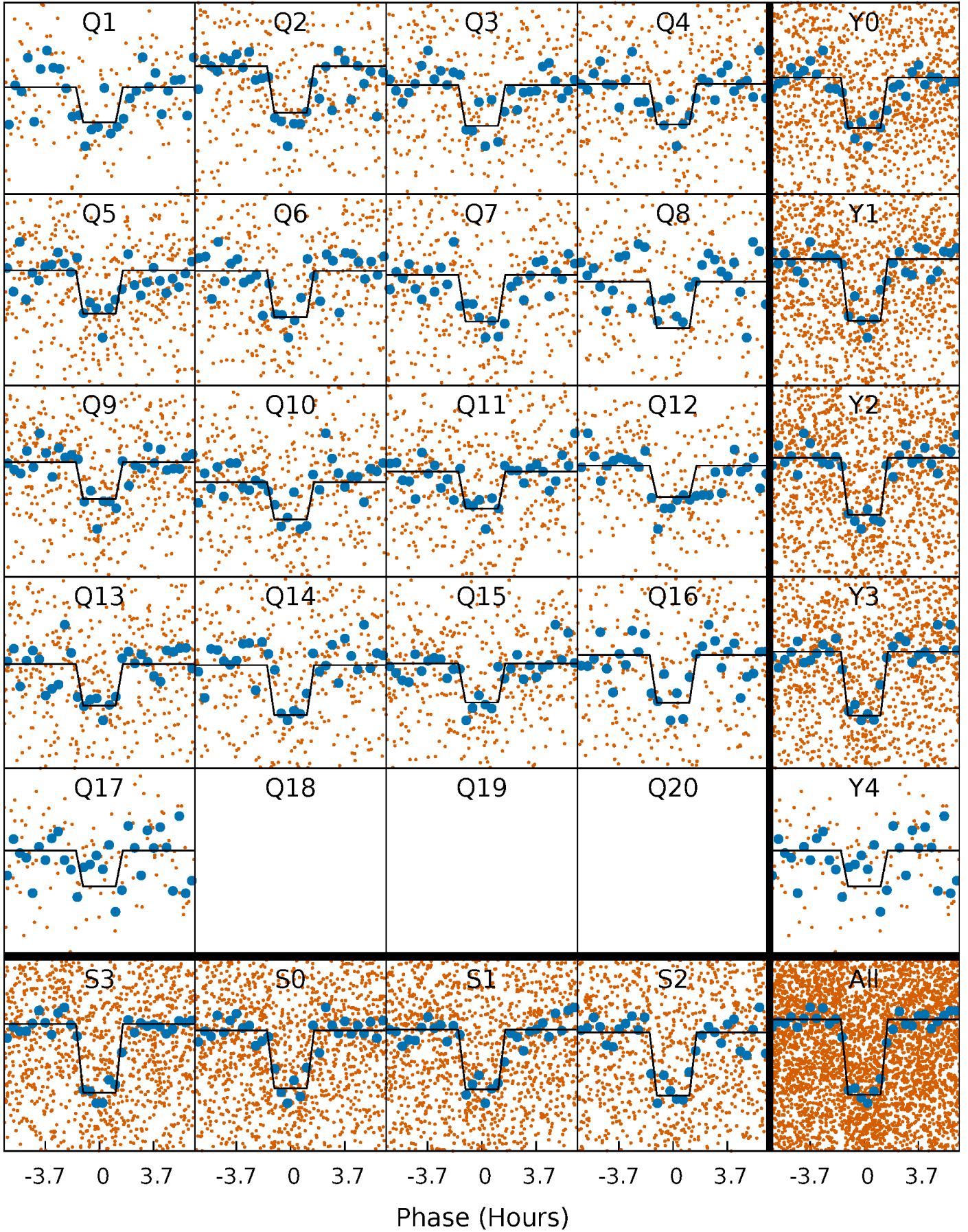
# DV Quarter-Phased Transit Curves

TCE 008753657-02   P= 4.623327 Days    $T_0=132.372896$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

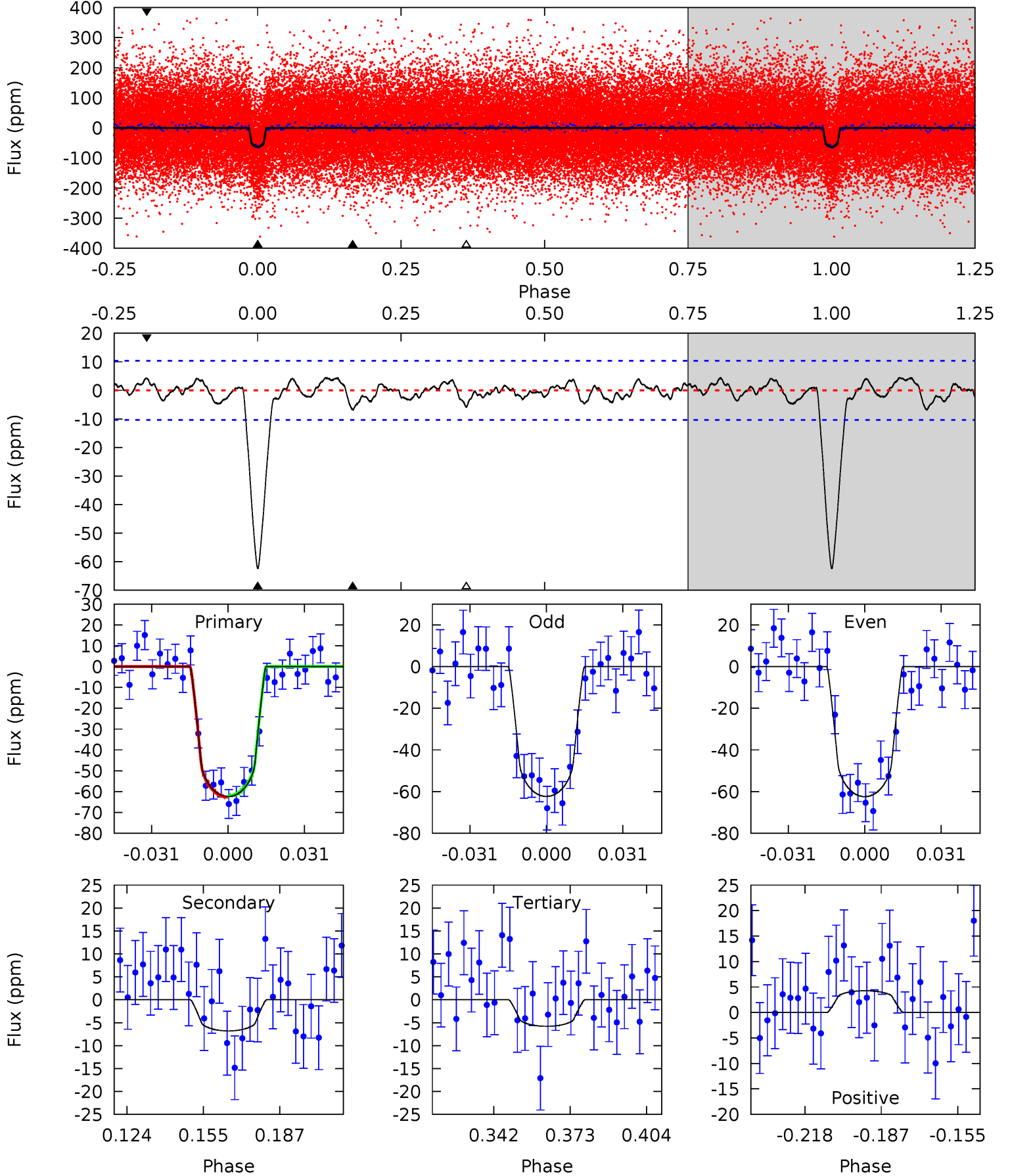
TCE 008753657-02   P= 4.623374 Days    $T_0=132.366361$  (BKJD)



# DV Model-Shift Uniqueness Test

008753657-02, P = 4.623327 Days, E = 127.749569 Days

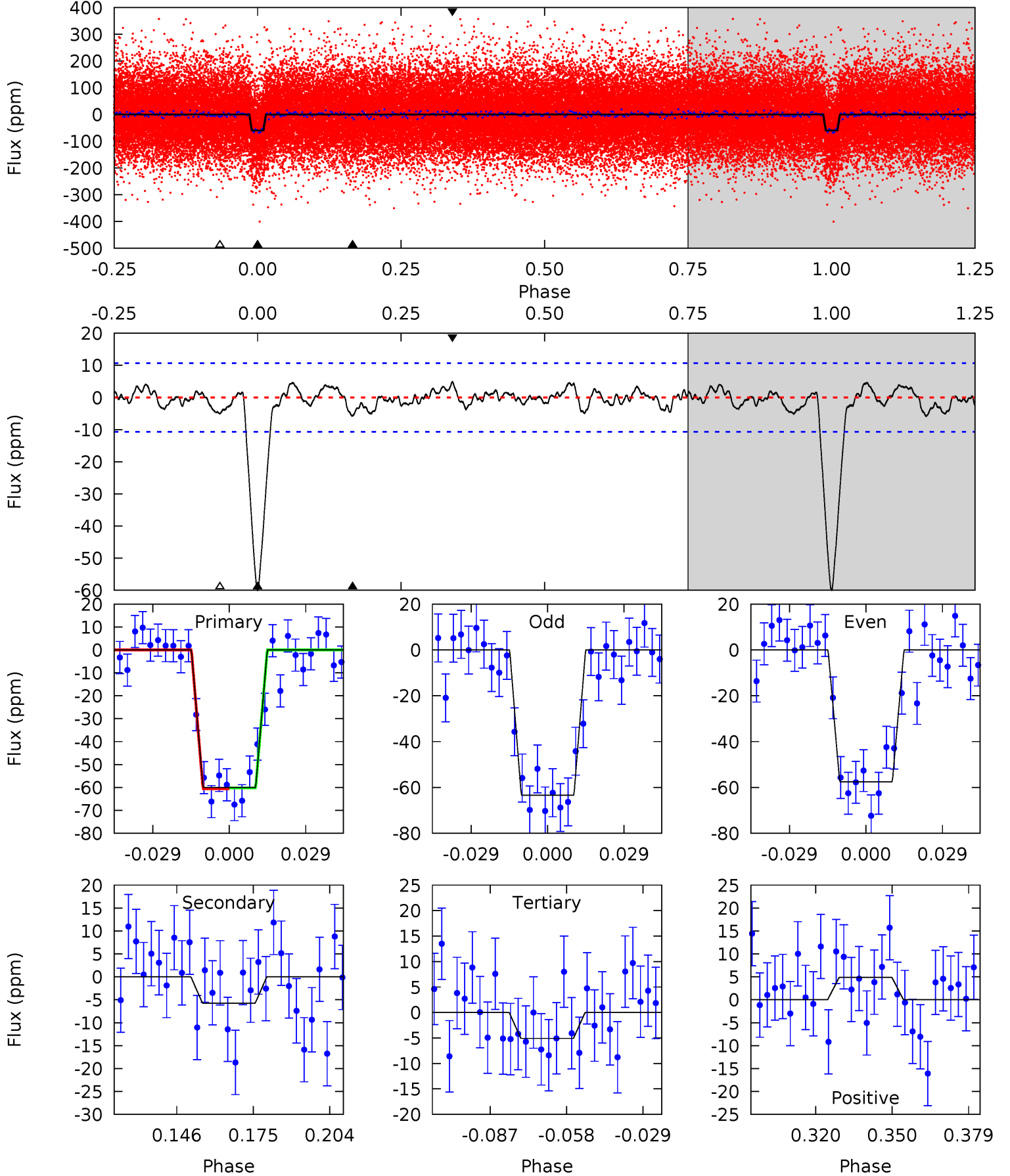
| Pri  | Sec  | Ter  | Pos  | FA <sub>1</sub> | FA <sub>2</sub> | F <sub>Red</sub> | Pri-Ter | Pri-Pos | Sec-Ter | Sec-Pos | Odd-Evn | DMM  | Shape | TAT  |
|------|------|------|------|-----------------|-----------------|------------------|---------|---------|---------|---------|---------|------|-------|------|
| 29.0 | 3.16 | 2.69 | 1.98 | 4.80            | 2.16            | 1.02             | 26.3    | 27.0    | 0.47    | 1.17    | 0.03    | 1.03 | 0.07  | 0.12 |



# Alt Model-Shift Uniqueness Test

008753657-02, P = 4.623374 Days, E = 127.742987 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  |
|------|------|------|------|-----------------|-----------------|------------------|---------|---------|---------|---------|---------|------|-------|------|
| 27.1 | 2.60 | 2.29 | 2.21 | 4.82            | 2.18            | 0.96             | 24.8    | 24.9    | 0.31    | 0.39    | 1.32    | 0.96 | 0.08  | 0.08 |



### Stellar Parameters For KIC 008753657

|        | $T_{\text{eff}}(K)$  | $\log(g)$                 | [Fe/H]                    | $R$ ( $R_{\odot}$ )       | $M(M_{\odot})$            | $p_{\star}$ ( $\text{g}\cdot\text{cm}^{-3}$ ) |
|--------|----------------------|---------------------------|---------------------------|---------------------------|---------------------------|---|
|        | $5678^{+102}_{-124}$ | $4.484^{+0.030}_{-0.120}$ | $0.260^{+0.150}_{-0.150}$ | $0.970^{+0.150}_{-0.053}$ | $1.043^{+0.044}_{-0.076}$ | $1.613^{+0.240}_{-0.550}$                     |
|        | +2%/-2%              | +1%/-3%                   | +58%/-58%                 | +15%/-5%                  | +4%/-7%                   | +15%/-34%                                     |
| Source | SPE59                | SPE59                     | SPE59                     | DSEP                      |                           |   |

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

### Secondary Eclipse Parameters for KIC 008753657-02 / KOI 0321.02

| Detrend | Depth (ppm) | $R_p$ ( $R_{\oplus}$ ) | $T_{\text{max}}$ (K) | $T_{\text{obs}}$ (K) | $A_{\text{obs}}$ |
|---------|-------------|------------------------|----------------------|----------------------|------------------|
| DV      | $-7 \pm 2$  | $0.94^{+0.31}_{-0.31}$ | $1485^{+62}_{-44}$   | $3540^{+525}_{-343}$ | $12^{+16}_{-6}$  |
| Alt.    | $-6 \pm 2$  | $0.83^{+0.30}_{-0.30}$ | $1484^{+61}_{-41}$   | $3561^{+686}_{-399}$ | $13^{+23}_{-7}$  |

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



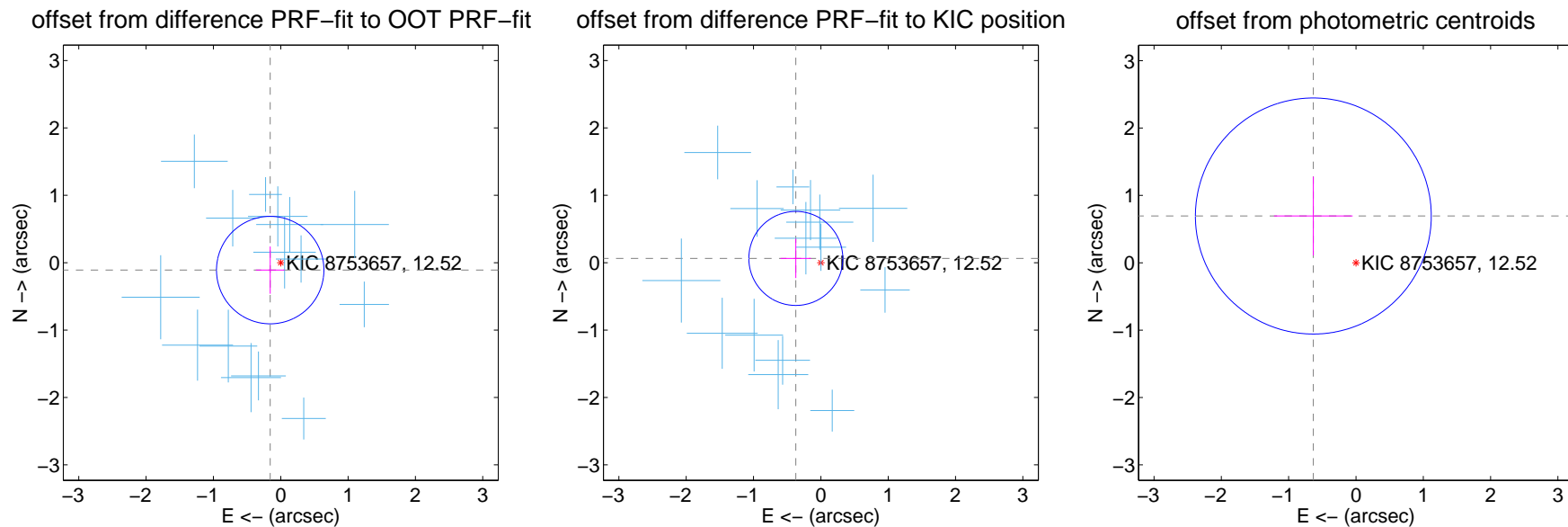
## DV Centroid Data

Supplemental centroid analysis for 008753657-02. Kepler magnitude: 12.52. Transit SNR 21.95

There are 15 quarters with good PRF difference image offsets

The direct PRF centroid is offset from the target star catalog position by about 0.38 arcsec

|   | Distance in arcsec | Distance / $\sigma$ | $\Delta$ RA       | $\Delta$ Dec       |
|---|--------------------|---------------------|-------------------|--------------------|
| PRF-fit source offset from OOT          | $0.191 \pm 0.266$  | 0.72                | $0.157 \pm 0.212$ | $-0.110 \pm 0.351$ |
| PRF-fit source offset from KIC position | $0.377 \pm 0.233$  | 1.62                | $0.372 \pm 0.226$ | $0.063 \pm 0.292$  |
| photometric centroid source offset      | $0.94 \pm 0.58$    | 1.61                | $0.63 \pm 0.58$   | $0.69 \pm 0.58$    |

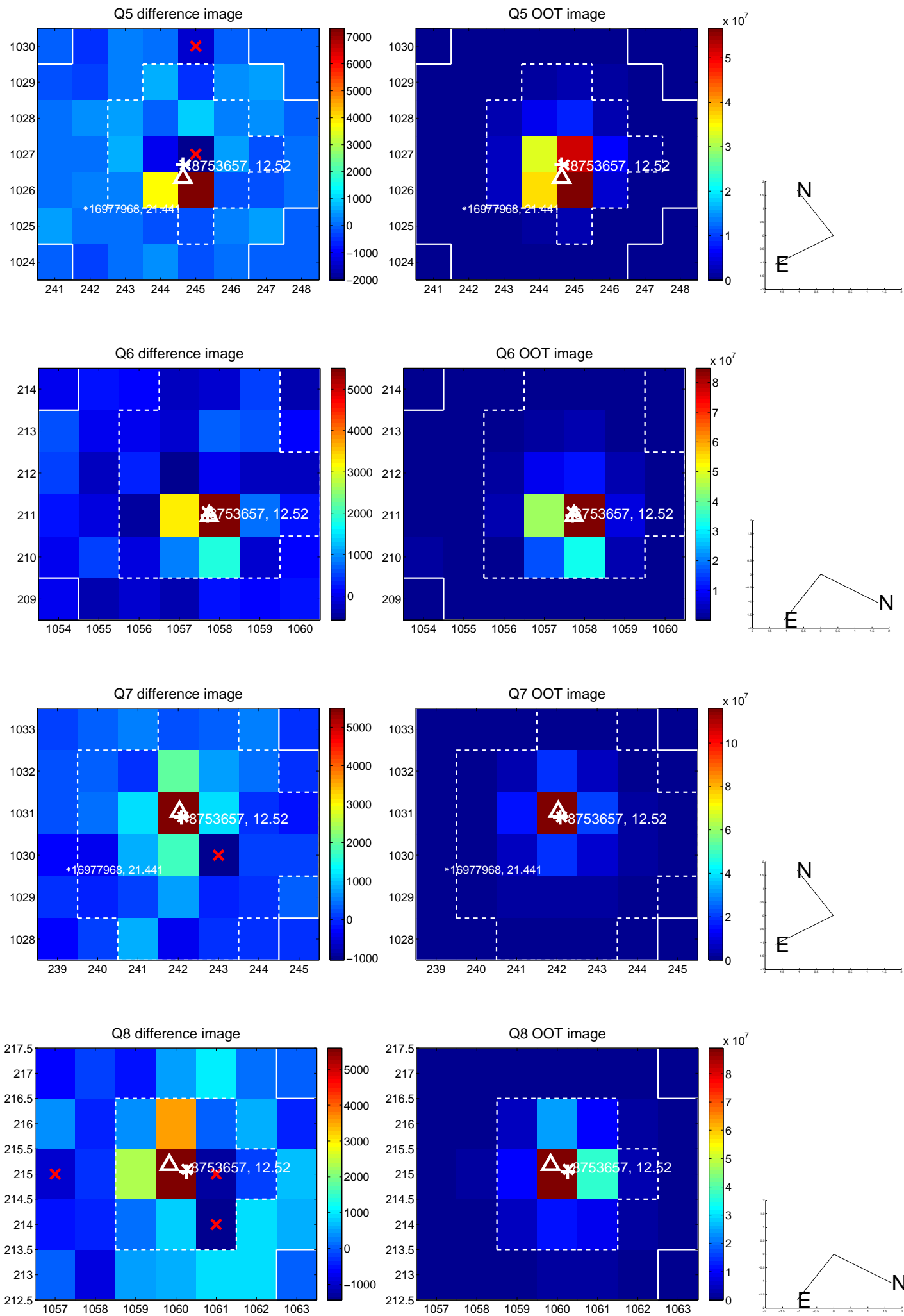


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses:** good quarterly centroid offsets; **Vermillion crosses:** bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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

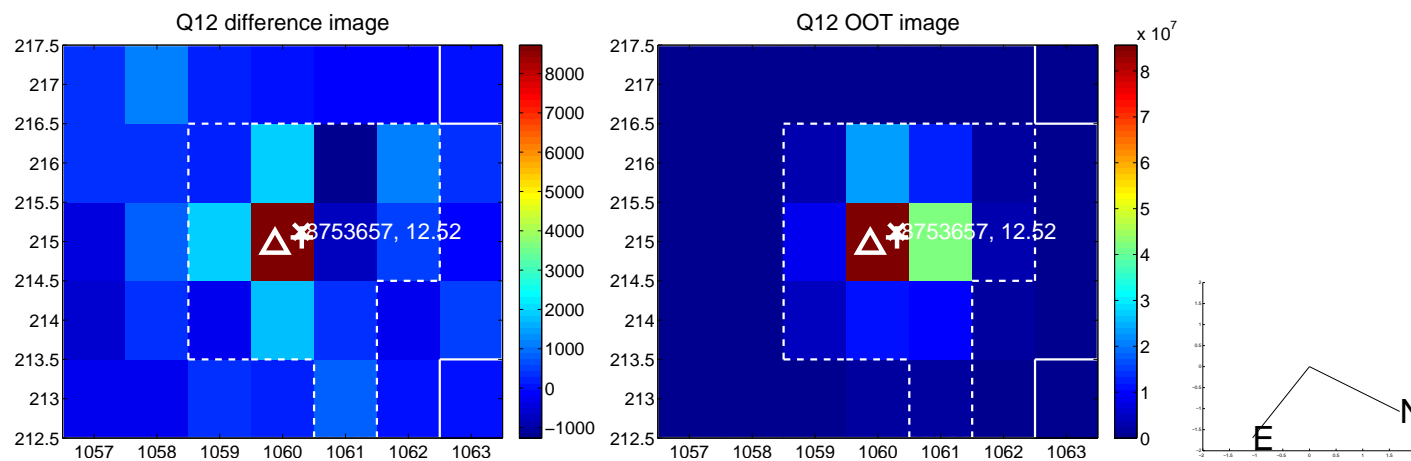
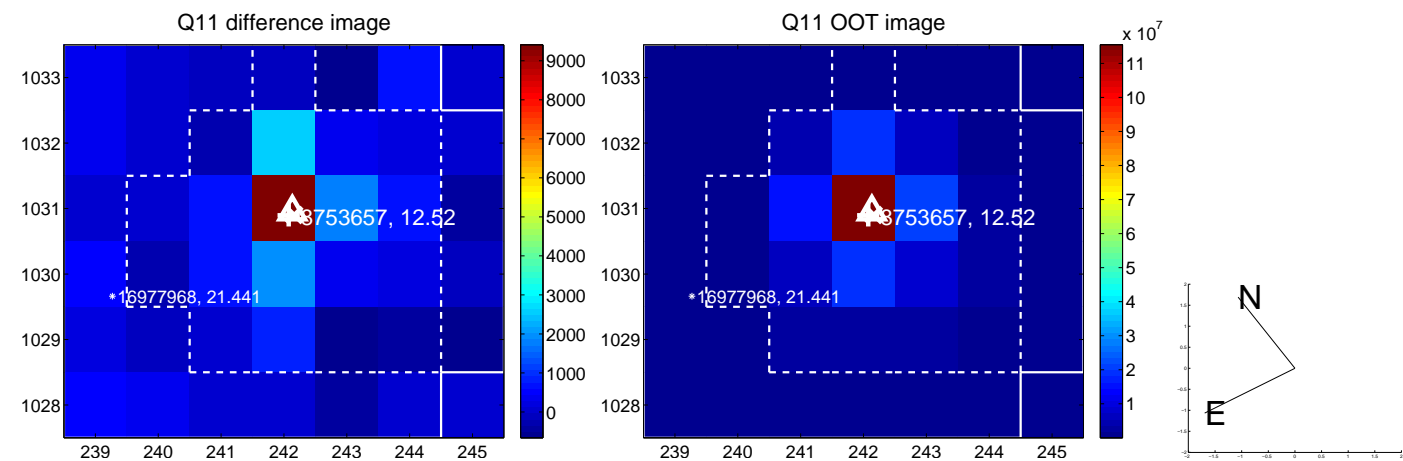
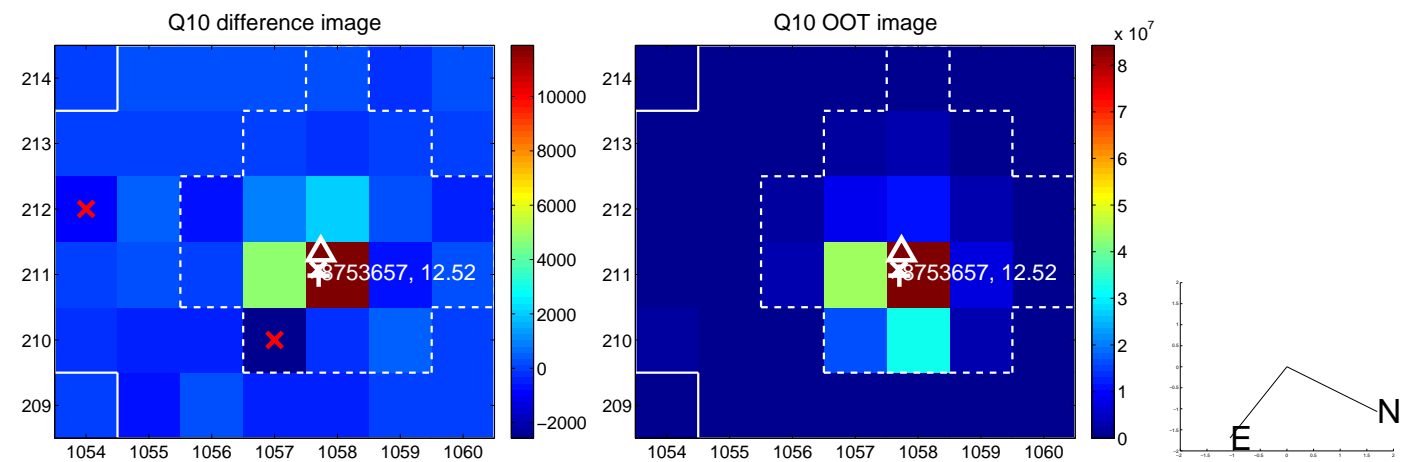
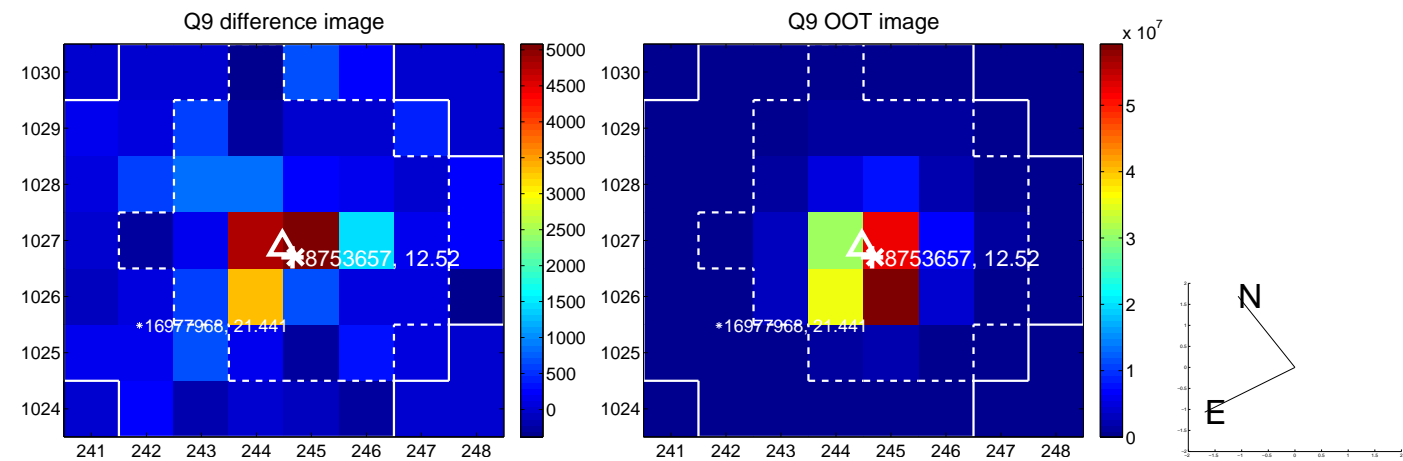




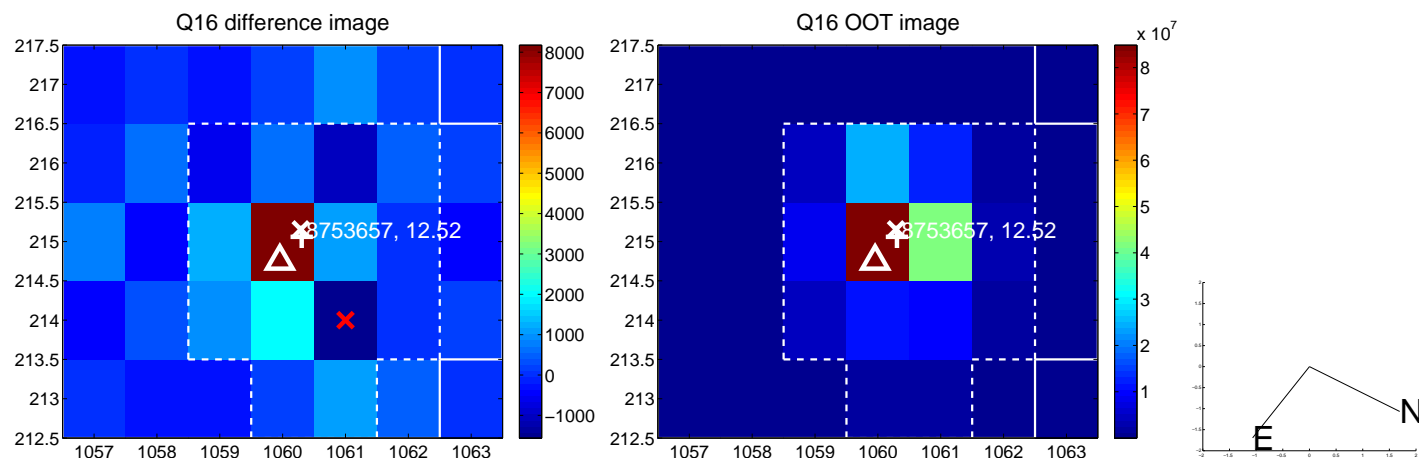
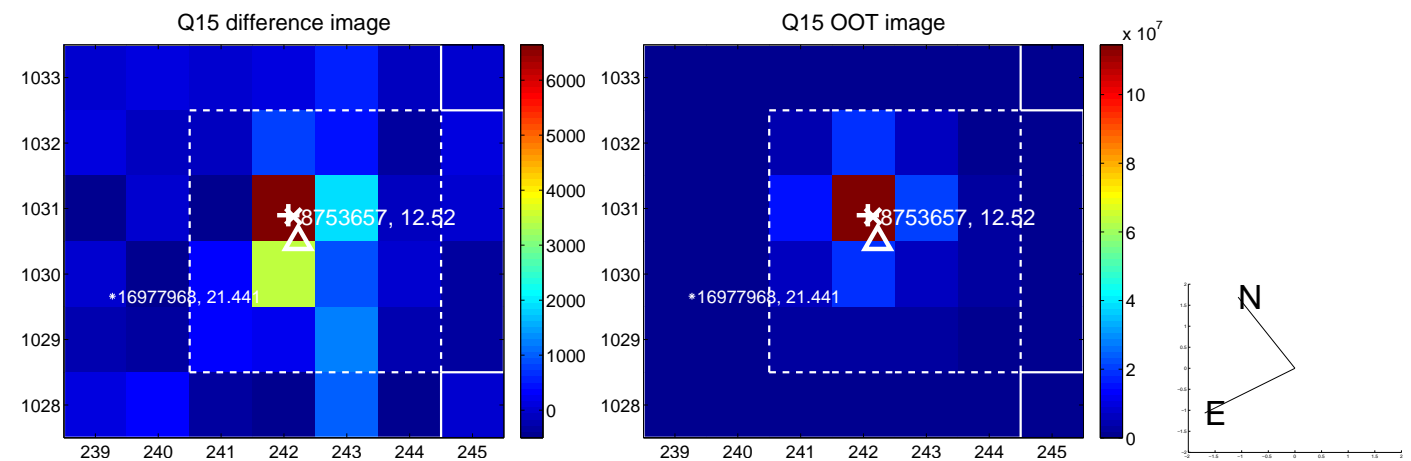
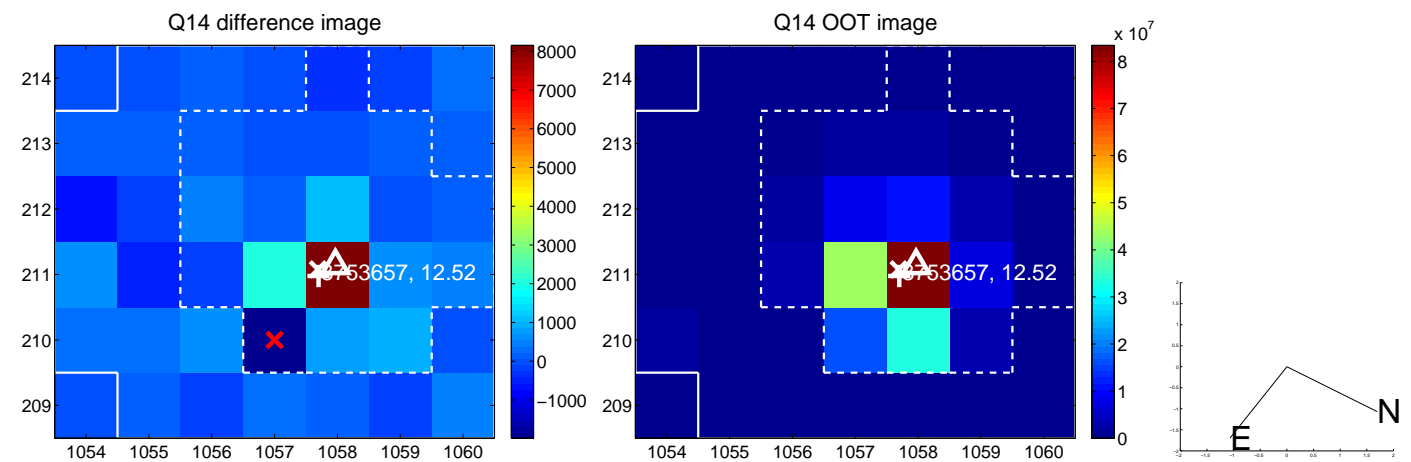
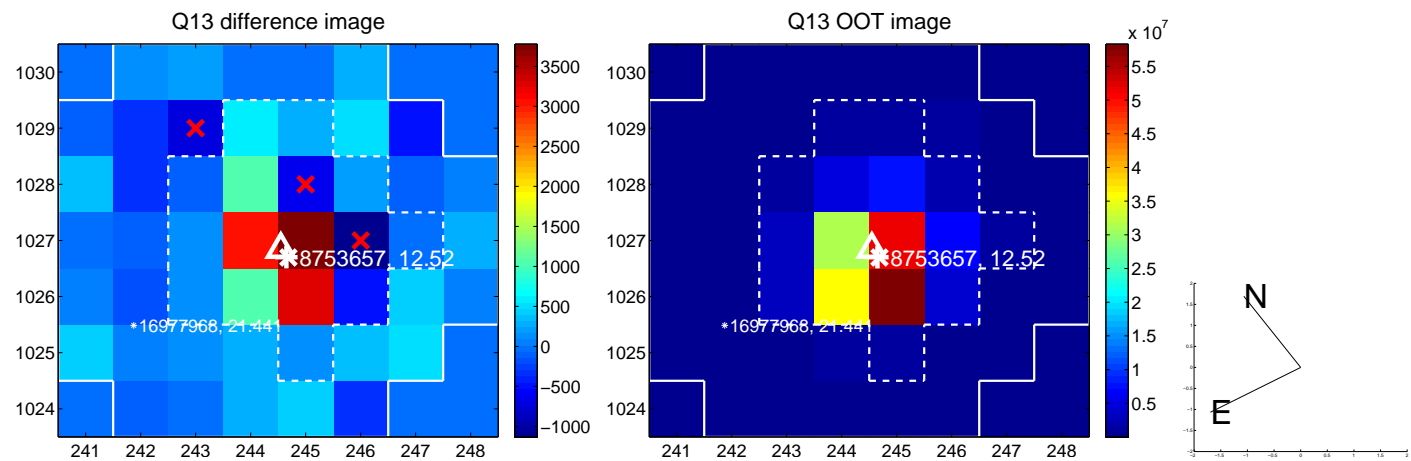
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



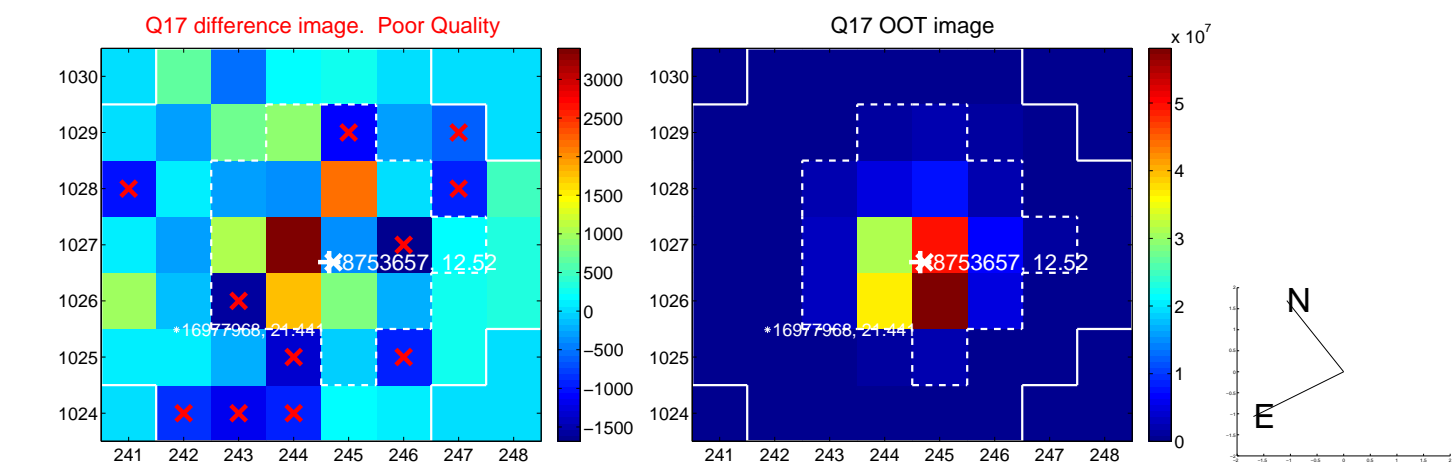
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



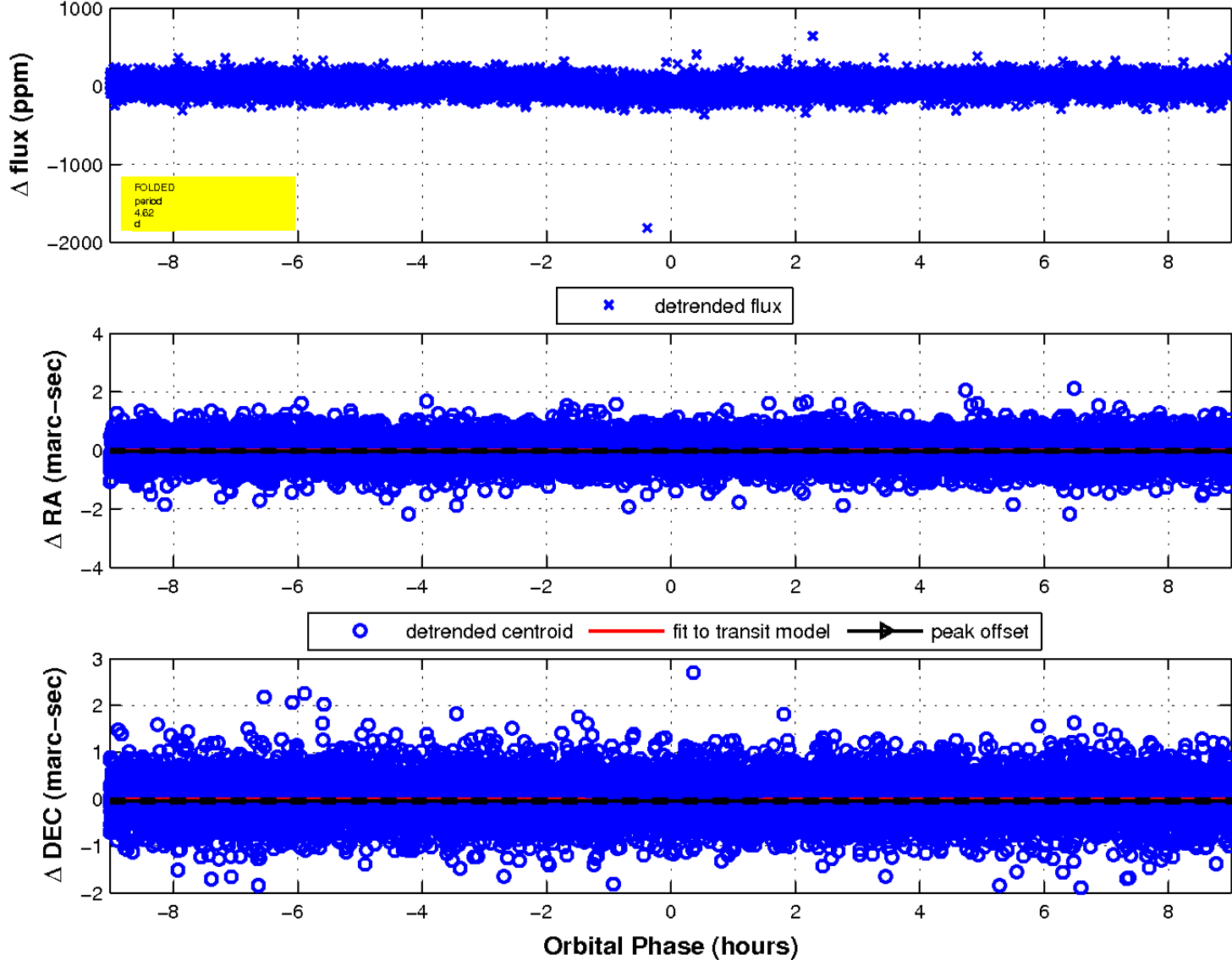
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fluxWeightedCentroids, Planet 2 of 2



UKIRT Image

Declination

