

KIC 005531576

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}) |
|--------------|----------|---------|---------------|--------------|-------------|------------------|------|------|-----------------------------|-----------------|------------------------|------------------------|
| 005531576-01 | OBS | 0837.01 | 7.953543 | 134.894264 | 869.3 | 2.828 | 31.9 | 35.4 | 0.78 | 4768 | 2.69 | 55.44 |
| 005531576-02 | OBS | 0837.02 | 4.144517 | 131.783966 | 371.2 | 2.538 | 18.5 | 20.4 | 0.78 | 4768 | 1.83 | 132.22 |

Robovetter Results

| TCE | Run Type | Disp | Score | N | S | C | E | Comments |
|--------------|----------|------|-------|---|---|---|---|------------|
| 005531576-01 | OBS | PC | 1.00 | 0 | 0 | 0 | 0 | NO_COMMENT |
| 005531576-02 | 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 for comment definitions.

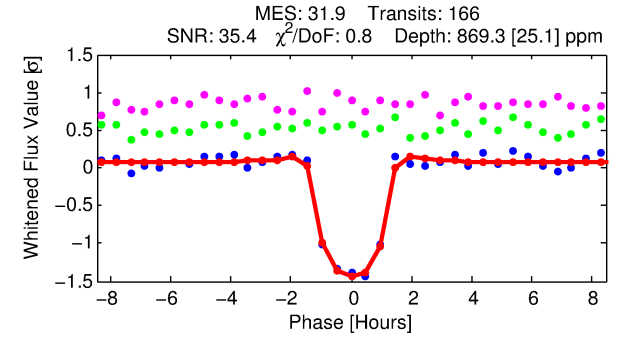
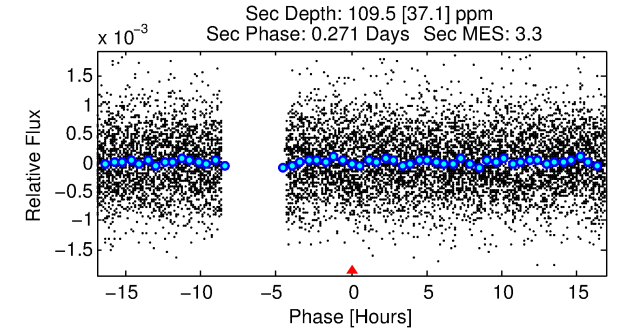
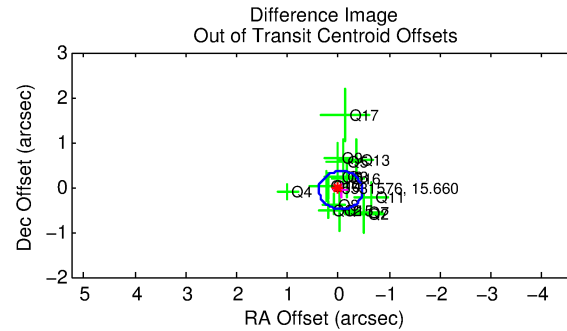
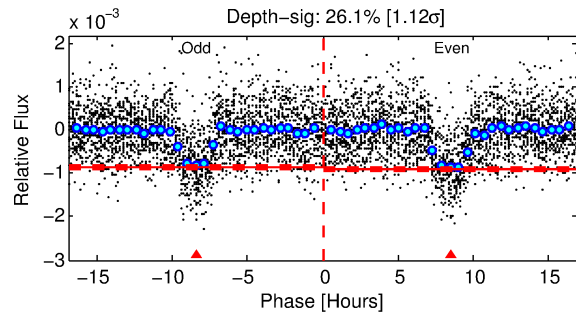
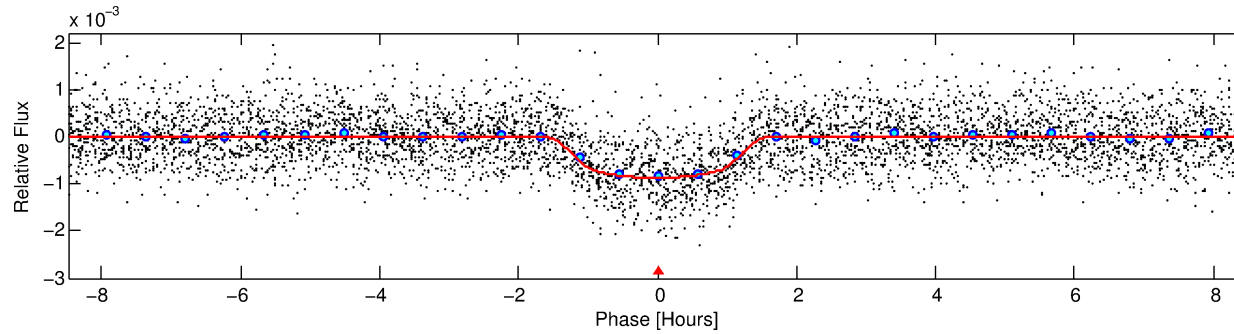
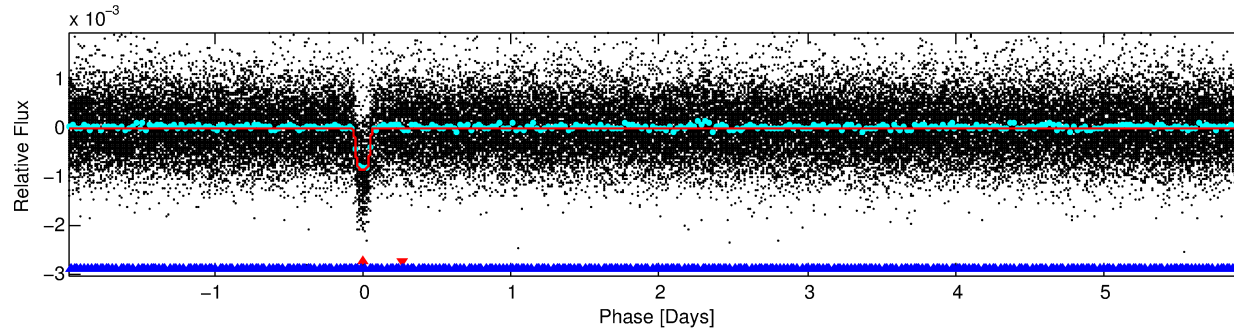
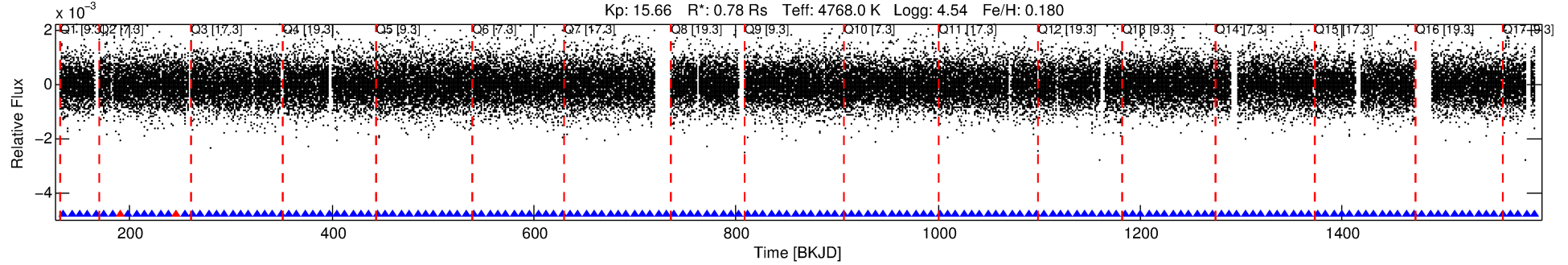
Ephemeris Match Information For 005531576-01

No Significant Match Found

DV One-Page Summary

KIC: 5531576 Candidate: 1 of 2 Period: 7.954 d
KOI: K00837.01 Name: Kepler-240c Corr: 0.964

Kp: 15.66 R*: 0.78 Rs Teff: 4768.0 K Logg: 4.54 Fe/H: 0.180



DV Fit Results:

Period = 7.95354 [0.00002] d
Epoch = 134.8943 [0.0016] BKJD
Rp/R* = 0.0316 [0.0050]
a/R* = 12.58 [6.85]
b = 0.85 [0.18]
Seff = 55.44 [6.61]
Teq = 696 [21] K
Rp = 2.69 [0.46] Re
a = 0.0712 [0.0043] AU
Ag = 42.33 [20.07] [2.06σ]
Teffp = 2744 [322] K [6.34σ]

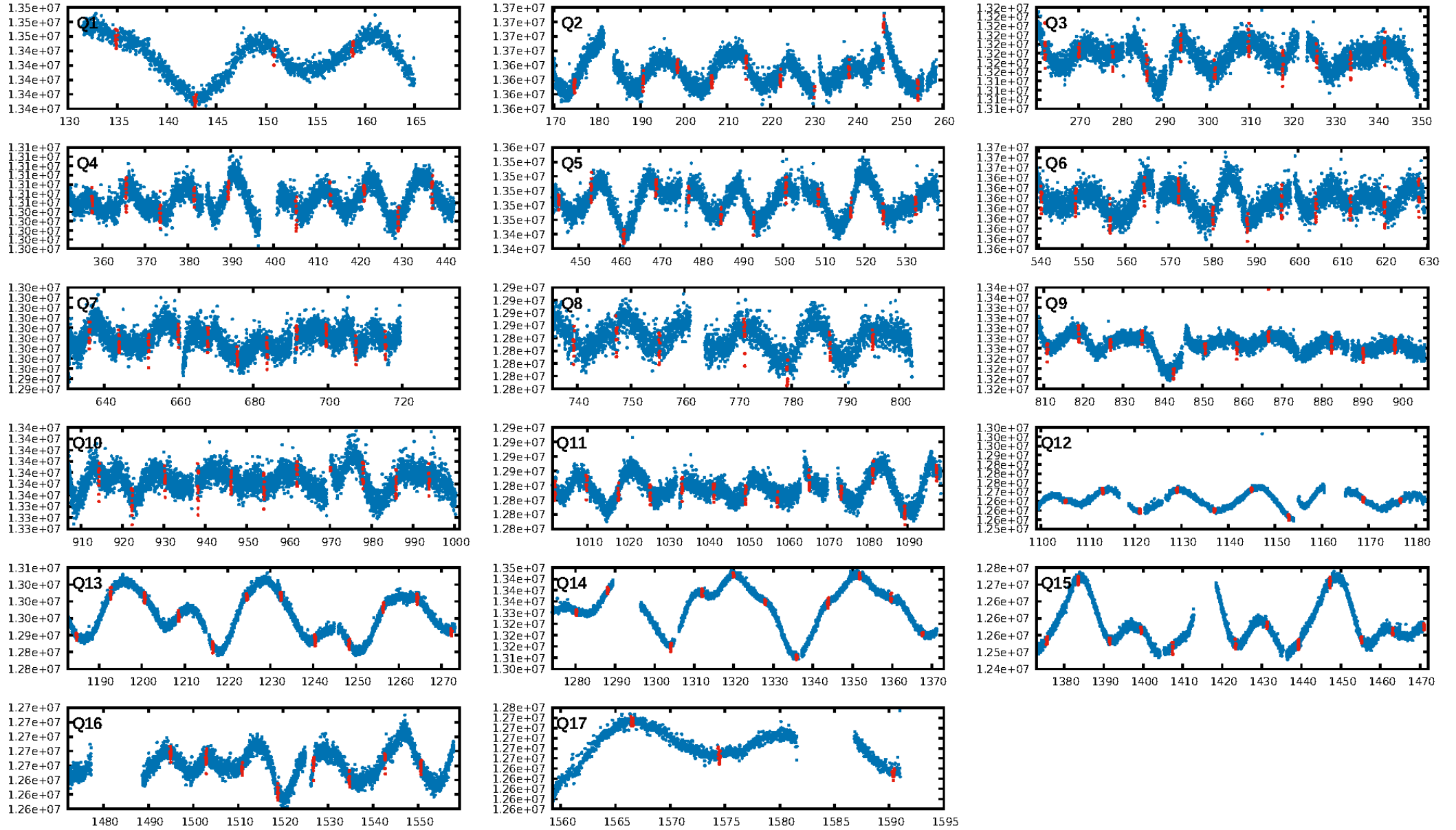
DV Diagnostic Results:

ShortPeriod-sig: 100.0% [24.06σ]
LongPeriod-sig: N/A
ModelChiSquare2-sig: 99.0%
ModelChiSquareGof-sig: 100.0%
Bootstrap-pfa: 5.21e-208
RollingBand-fgt: 0.99 [157/159]
GhostDiagnostic-chr: 4.847
Centroid-sig: 33.4%
Centroid-so: 0.281 arcsec [0.82σ]
OotOffset-rm: 0.085 arcsec [0.59σ]
KicOffset-rm: 0.176 arcsec [1.06σ]
OotOffset-st: 4/4/4/4 [16]
KicOffset-st: 4/4/4/4 [16]
DiffImageQuality-fgm: 1.00 [16/16]
DiffImageOverlap-fno: 1.00 [17/17]

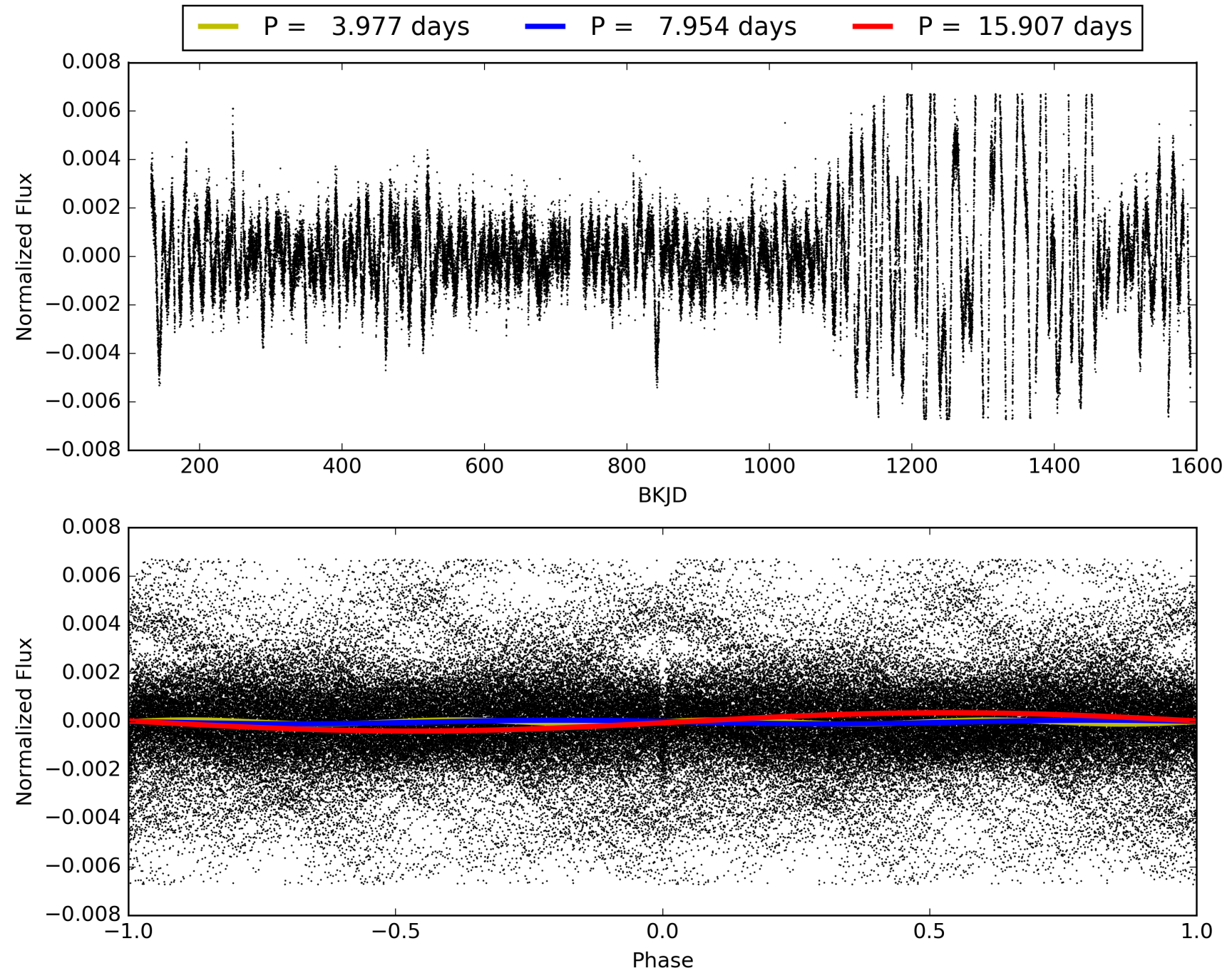
Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 31-Jan-2016 11:16:20 Z

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

TCE 005531576-01, PDC Light Curves

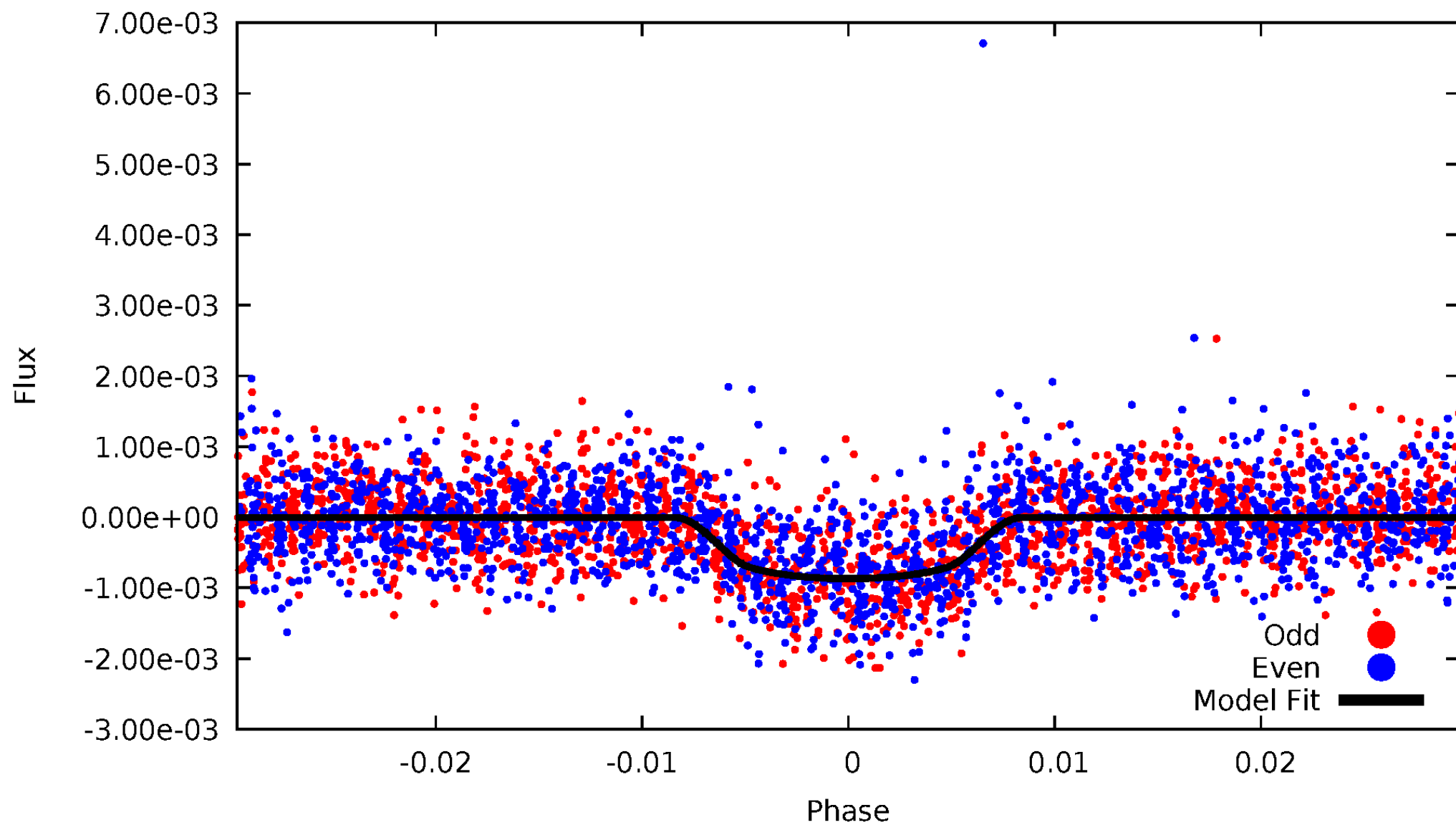


TCE 005531576-01



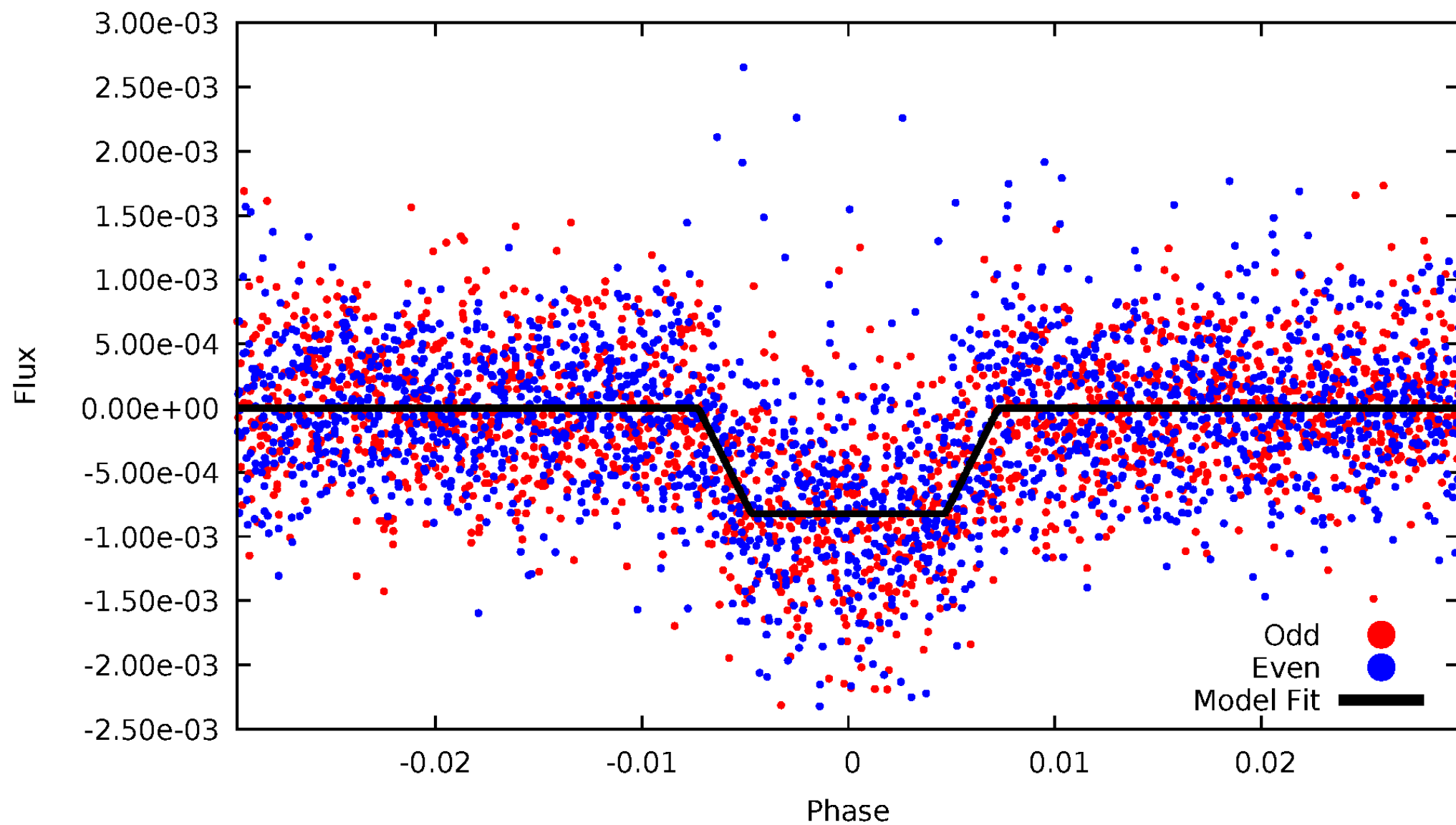
DV Odd/Even

TCE 005531576-01



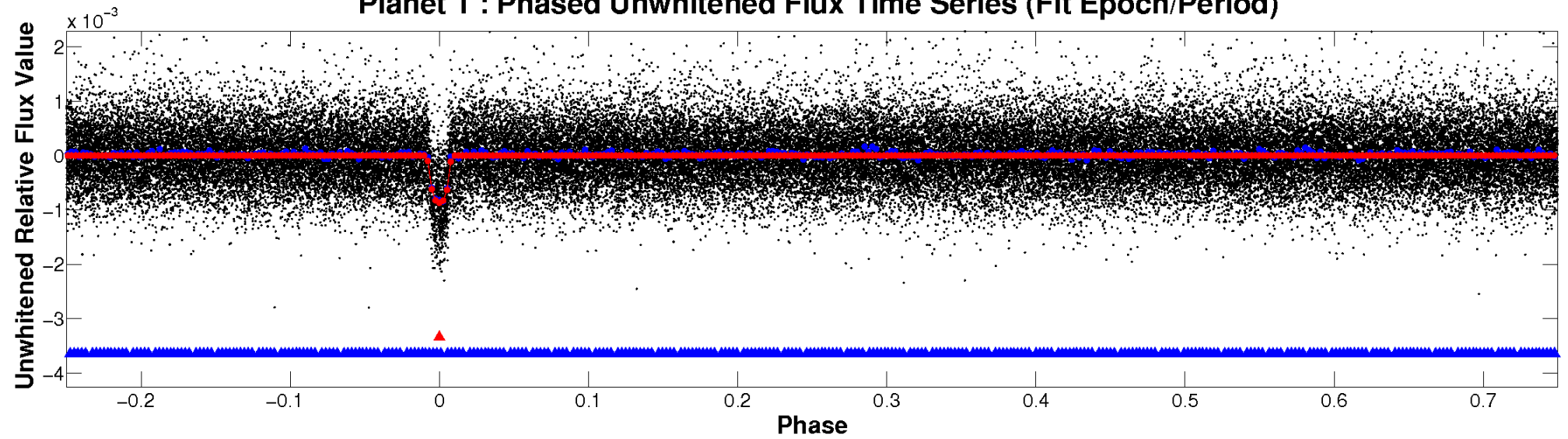
ALT Odd/Even

TCE 005531576-01

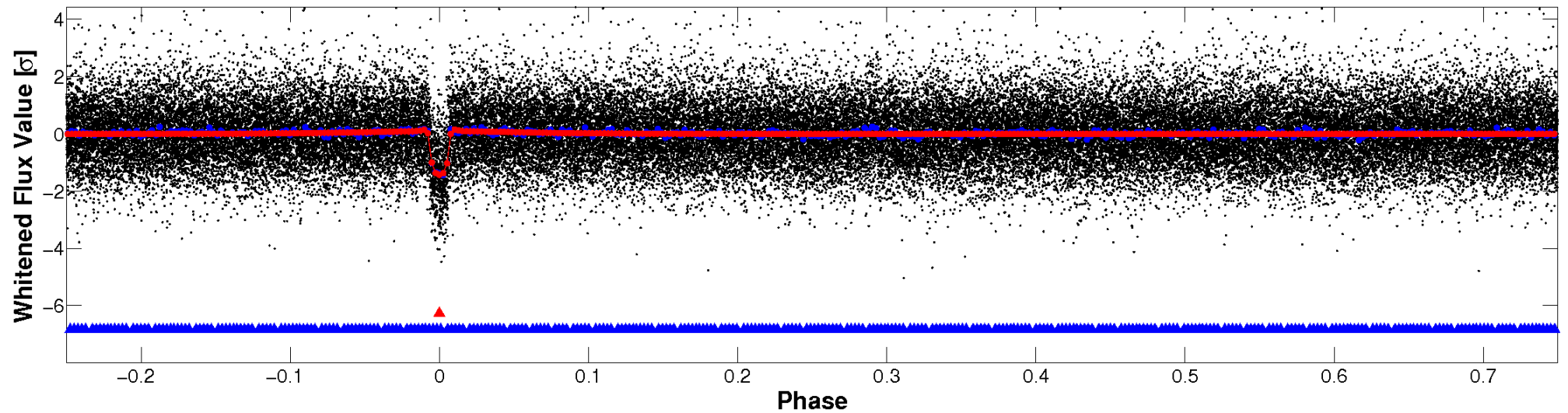


Non-Whitened Vs. Whitened Light Curve

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

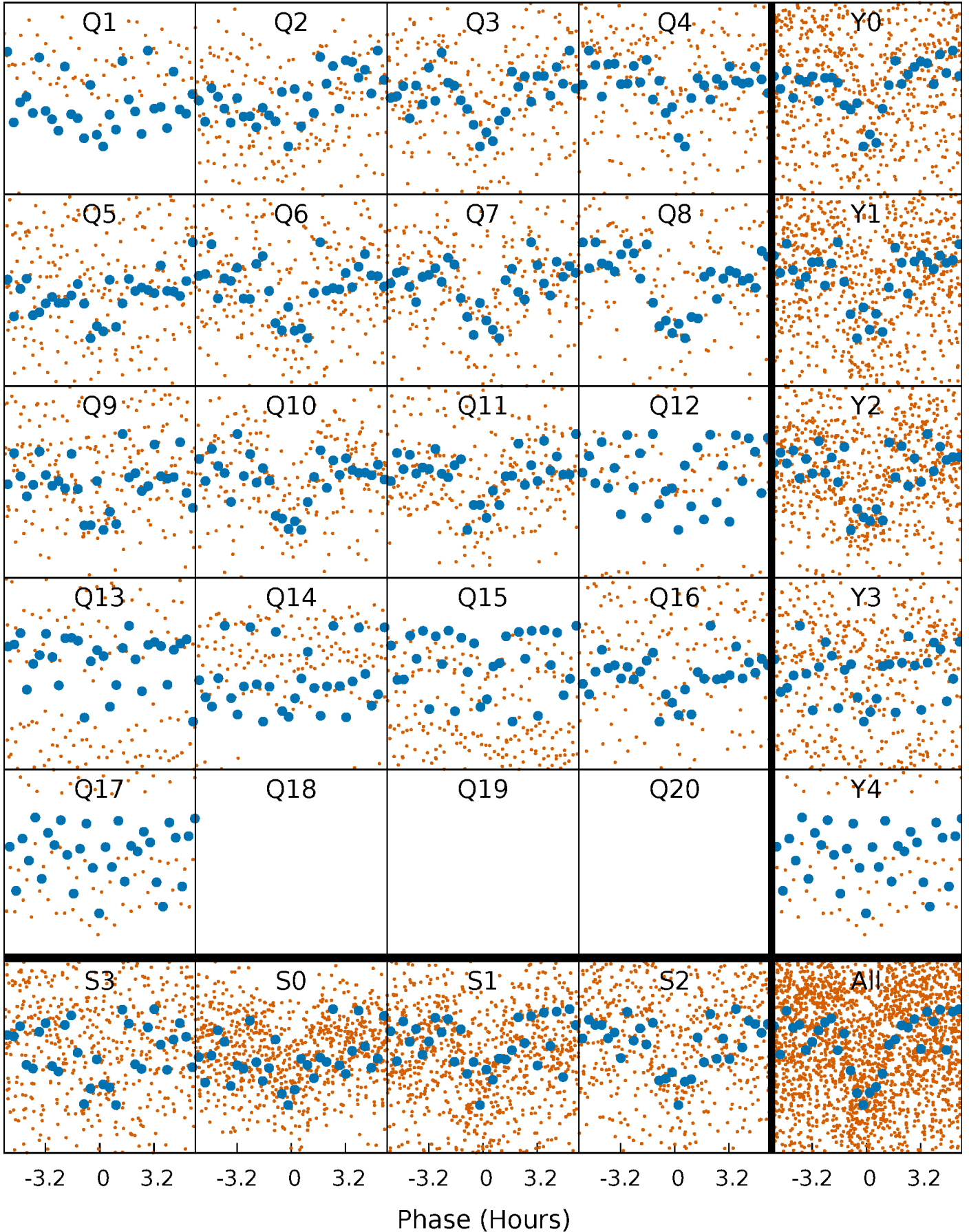


Planet 1 : Phased Whitened Flux Time Series (Fit Epoch/Period)



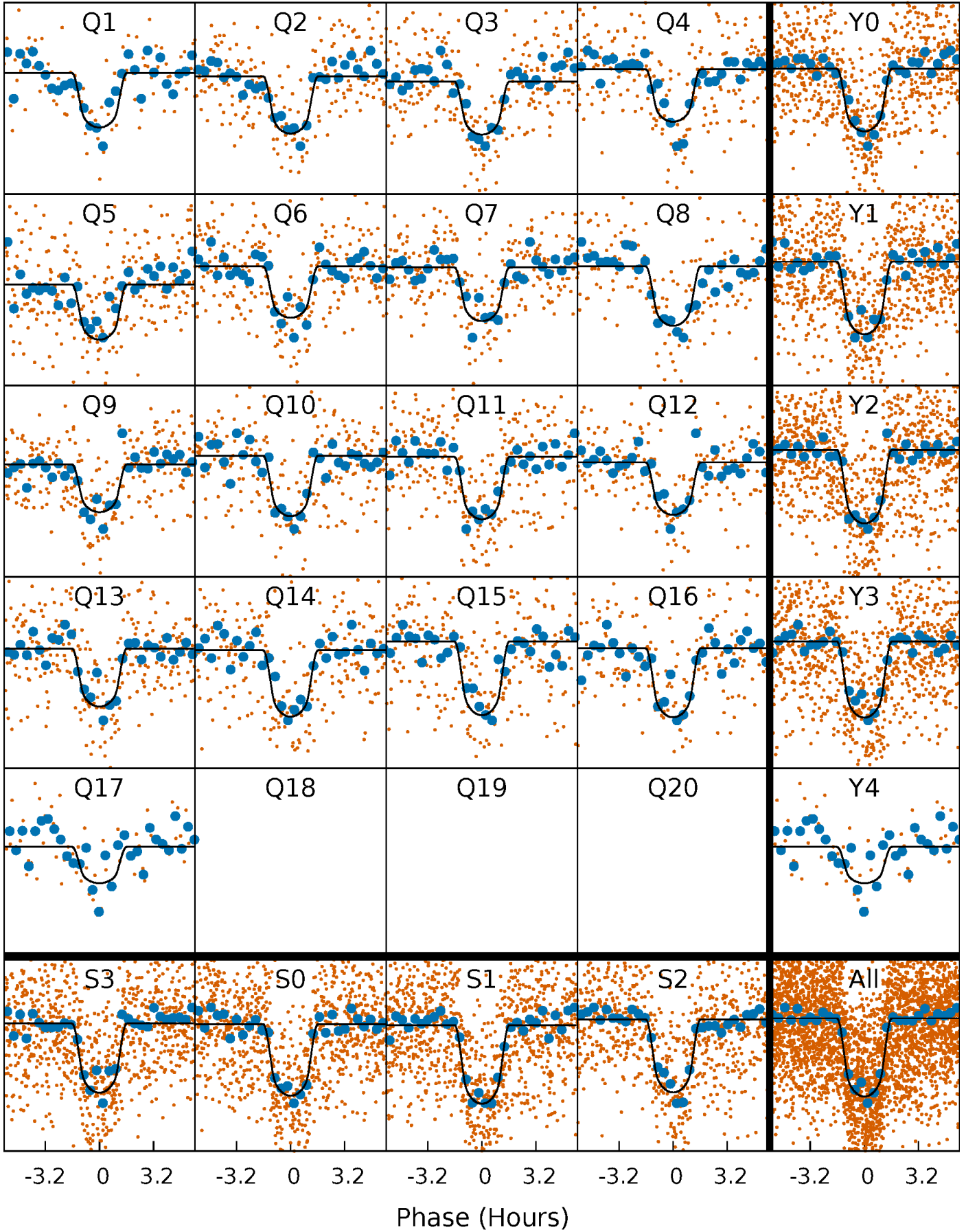
PDC Quarter-Phased Transit Curves

TCE 005531576-01 P= 7.953543 Days $T_0=134.894264$ (BKJD)



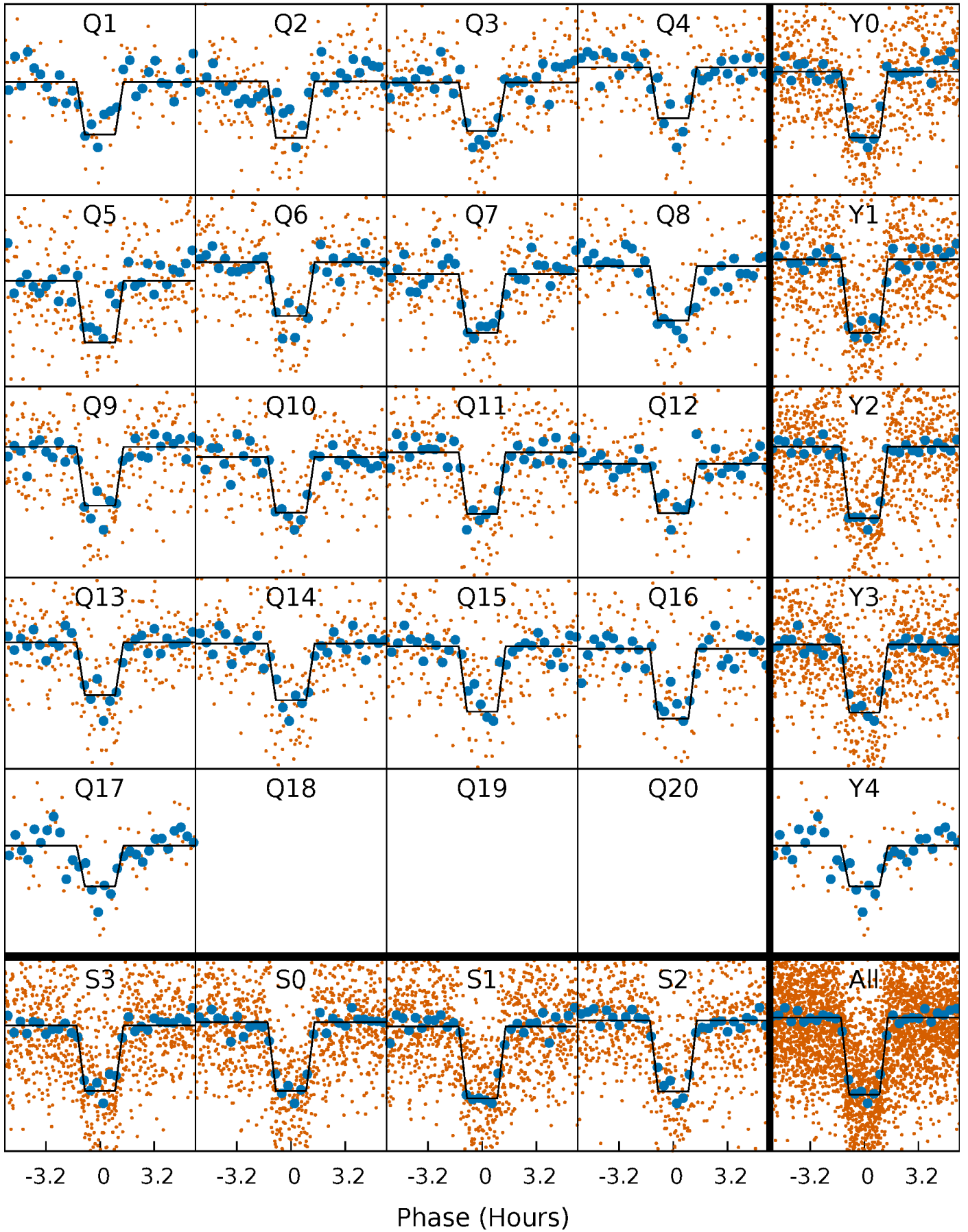
DV Quarter-Phased Transit Curves

TCE 005531576-01 P= 7.953543 Days $T_0=134.894264$ (BKJD)



Alt. Detrend Quarter-Phased Transit Curves

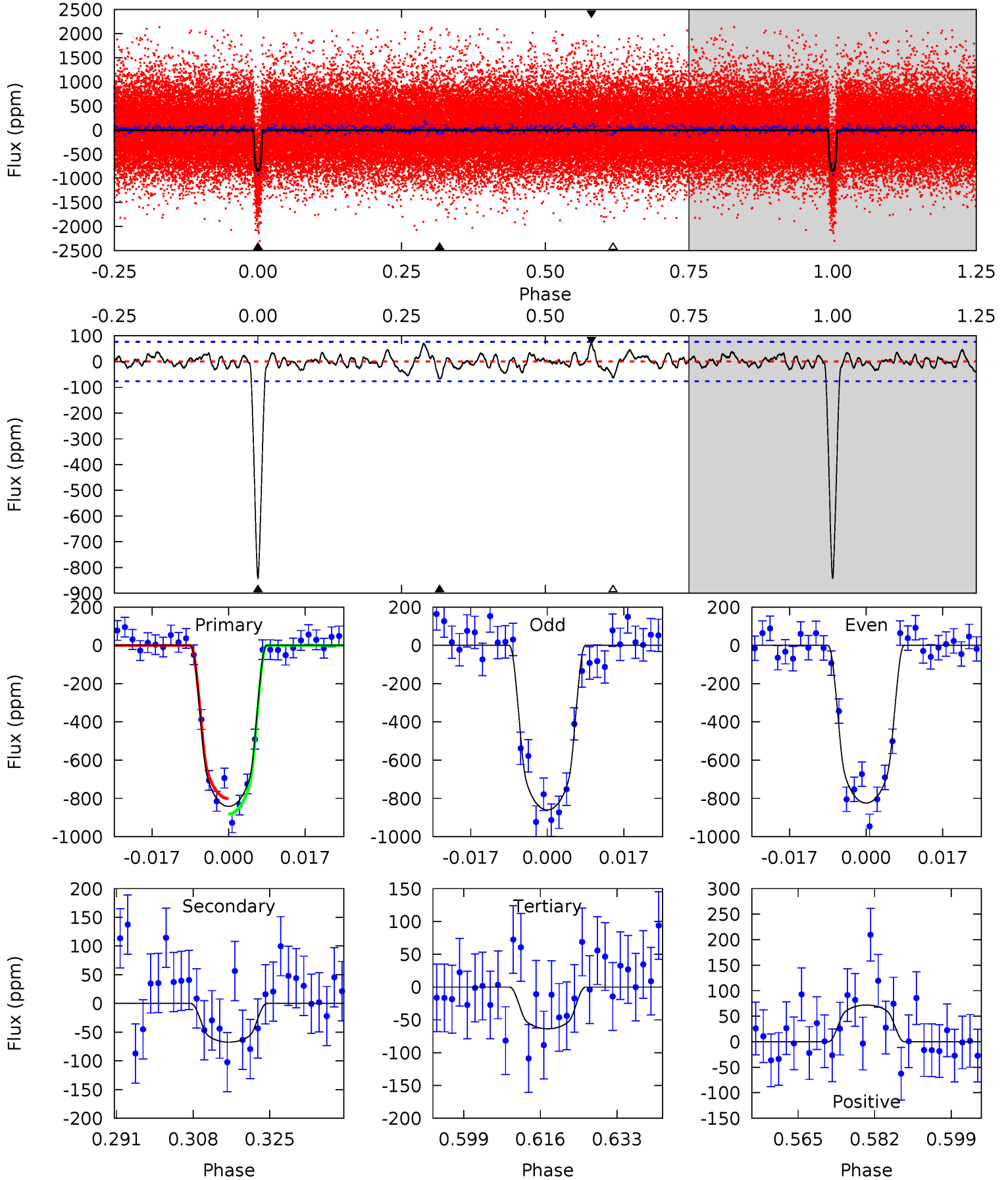
TCE 005531576-01 P= 7.953494 Days $T_0=134.899389$ (BKJD)



DV Model-Shift Uniqueness Test

005531576-01, P = 7.953543 Days, E = 126.940721 Days

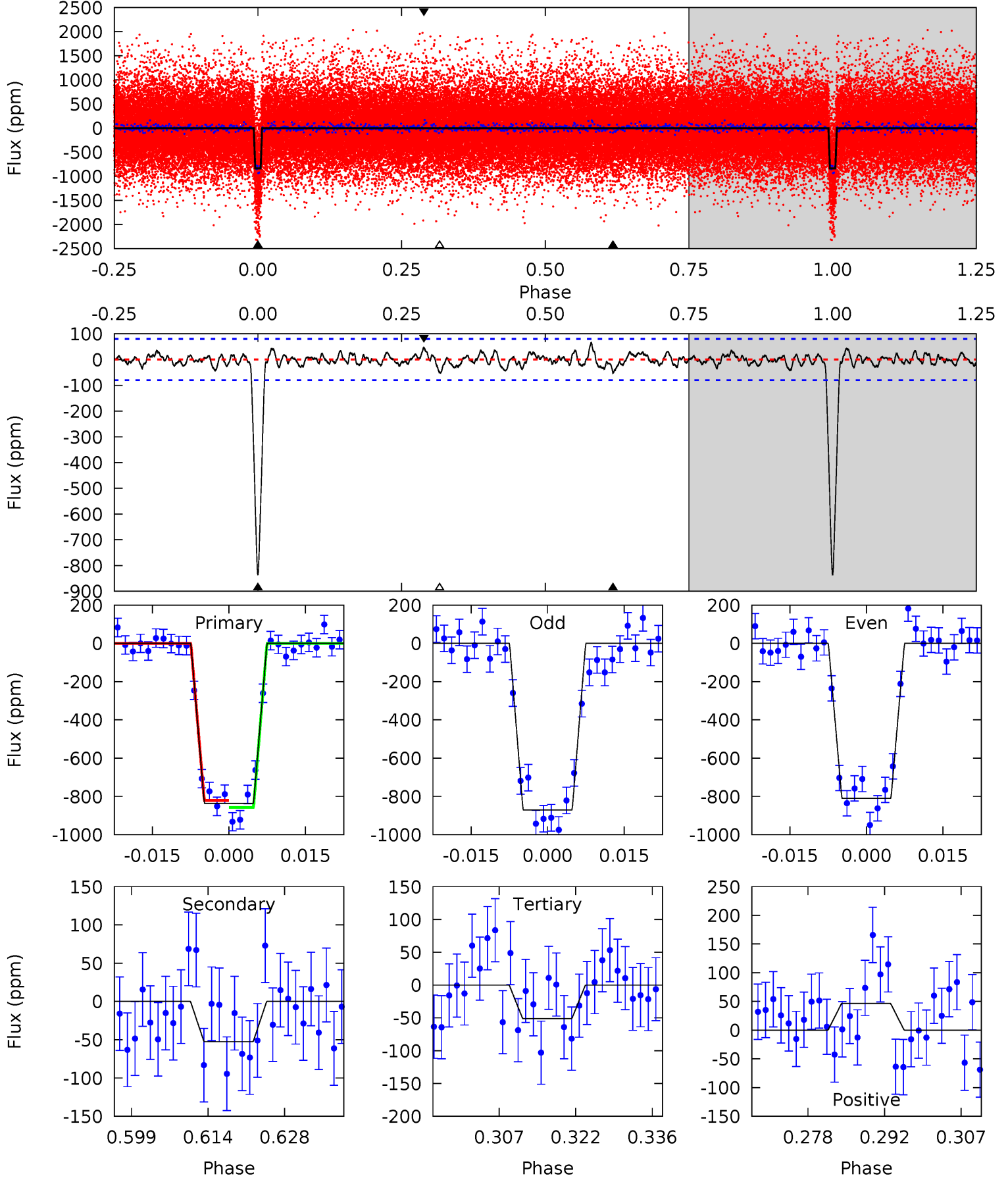
| Pri | Sec | Ter | Pos | FA ₁ | FA ₂ | F _{Red} | Pri-Ter | Pri-Pos | Sec-Ter | Sec-Pos | Odd-Evn | DMM | Shape | TAT |
|------|------|------|------|-----------------|-----------------|------------------|---------|---------|---------|---------|---------|------|-------|------|
| 54.2 | 4.34 | 4.10 | 4.63 | 4.92 | 2.38 | 1.37 | 50.1 | 49.6 | 0.24 | -0.29 | 1.15 | 0.96 | 0.08 | 2.59 |



Alt Model-Shift Uniqueness Test

005531576-01, P = 7.953494 Days, E = 126.945895 Days

| Pri | Sec | Ter | Pos | FA ₁ | FA ₂ | F _{Red} | Pri-Ter | Pri-Pos | Sec-Ter | Sec-Pos | Odd-Evn | DMM | Shape | TAT |
|------|------|------|------|-----------------|-----------------|------------------|---------|---------|---------|---------|---------|------|-------|------|
| 51.8 | 3.25 | 3.17 | 2.87 | 4.95 | 2.44 | 1.11 | 48.7 | 49.0 | 0.08 | 0.38 | 1.89 | 0.96 | 0.07 | 1.13 |



Stellar Parameters For KIC 005531576

| | $T_{\text{eff}}(K)$ | $\log(g)$ | $[\text{Fe}/\text{H}]$ | $R (R_{\odot})$ | $M(M_{\odot})$ | $p_{\star} (\text{g}\cdot\text{cm}^{-3})$ |
|--------|---------------------|---------------------------|---------------------------|---------------------------|---------------------------|---|
| | 4768^{+76}_{-85} | $4.536^{+0.056}_{-0.016}$ | $0.180^{+0.150}_{-0.150}$ | $0.779^{+0.023}_{-0.049}$ | $0.759^{+0.046}_{-0.027}$ | $2.266^{+0.484}_{-0.151}$ |
| | +2%/-2% | +1%/-0% | +83%/-83% | +3%/-6% | +6%/-4% | +21%/-7% |
| Source | SPE90 | SPE90 | SPE90 | DSEP | | |

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

Secondary Eclipse Parameters for KIC 005531576-01 / KOI 0837.01

| Detrend | Depth (ppm) | $R_p (R_{\oplus})$ | $T_{\text{max}} (K)$ | $T_{\text{obs}} (K)$ | A_{obs} |
|---------|--------------|------------------------|----------------------|----------------------|------------------|
| DV | -67 ± 16 | $2.66^{+0.41}_{-0.47}$ | 966^{+19}_{-22} | 3030^{+185}_{-177} | 27^{+13}_{-9} |
| Alt. | -52 ± 16 | $2.42^{+0.44}_{-0.42}$ | 966^{+20}_{-21} | 2978^{+215}_{-211} | 24^{+15}_{-9} |

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

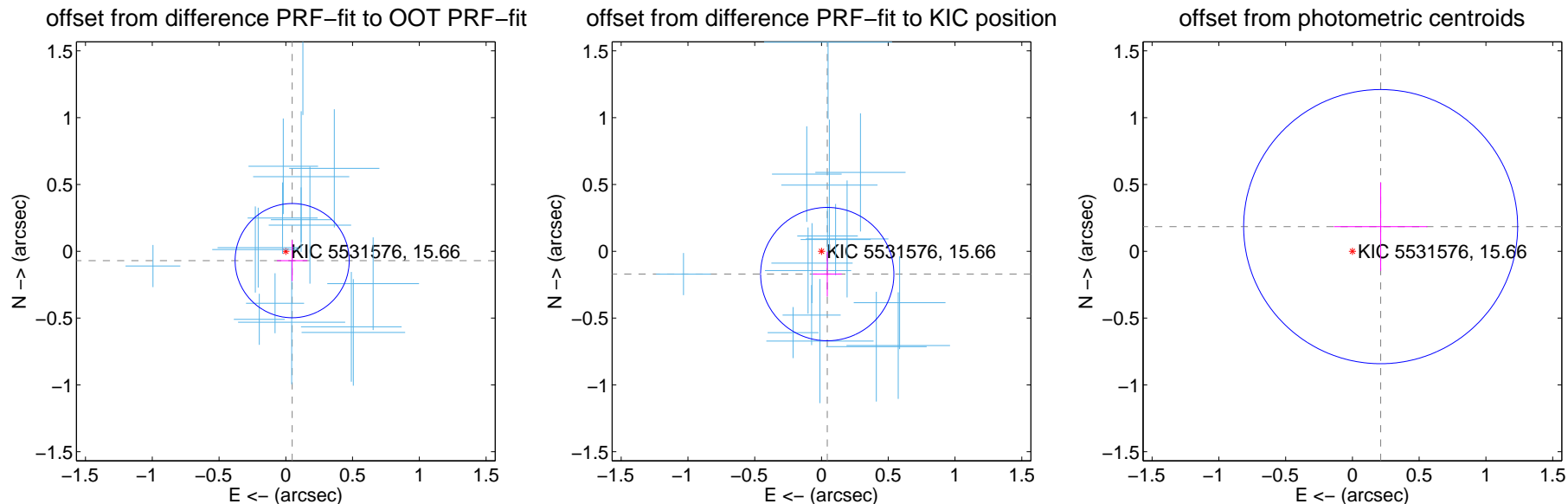
DV Centroid Data

Supplemental centroid analysis for 005531576-01. Kepler magnitude: 15.66. Transit SNR 35.36

There are 16 quarters with good PRF difference image offsets

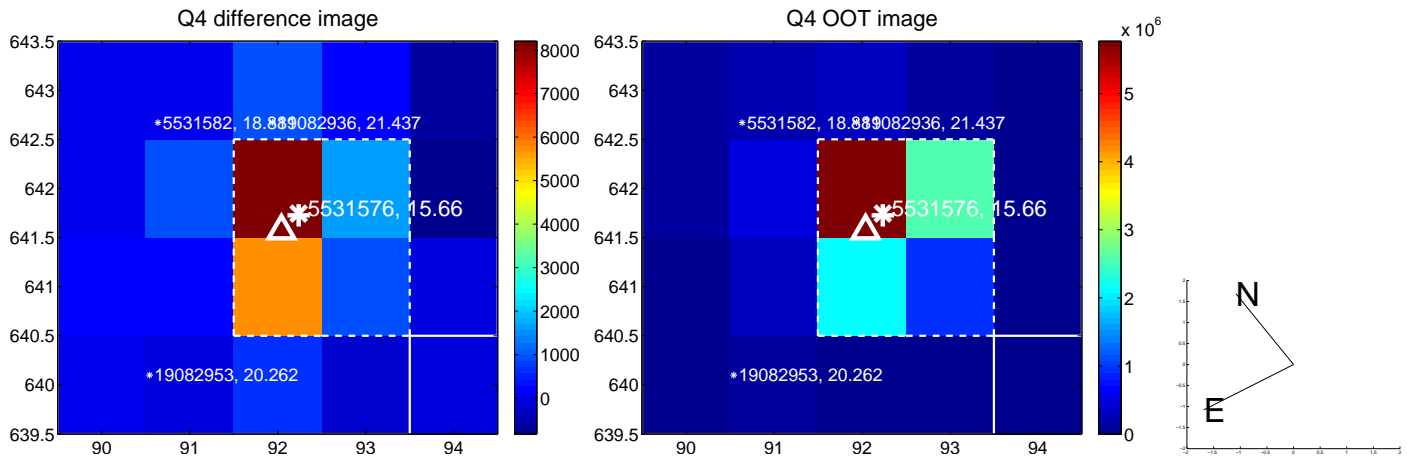
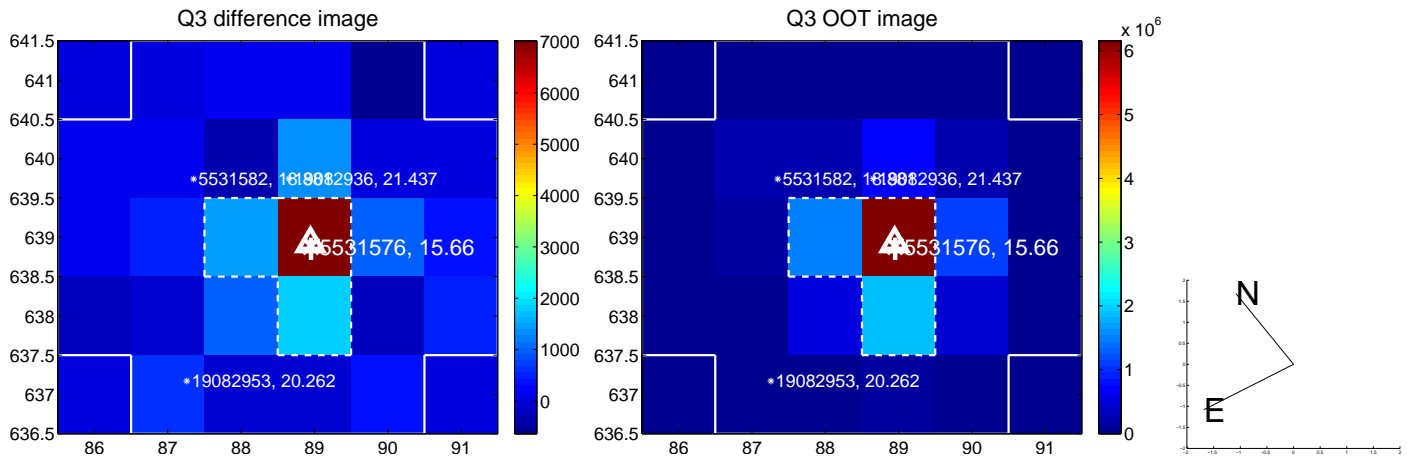
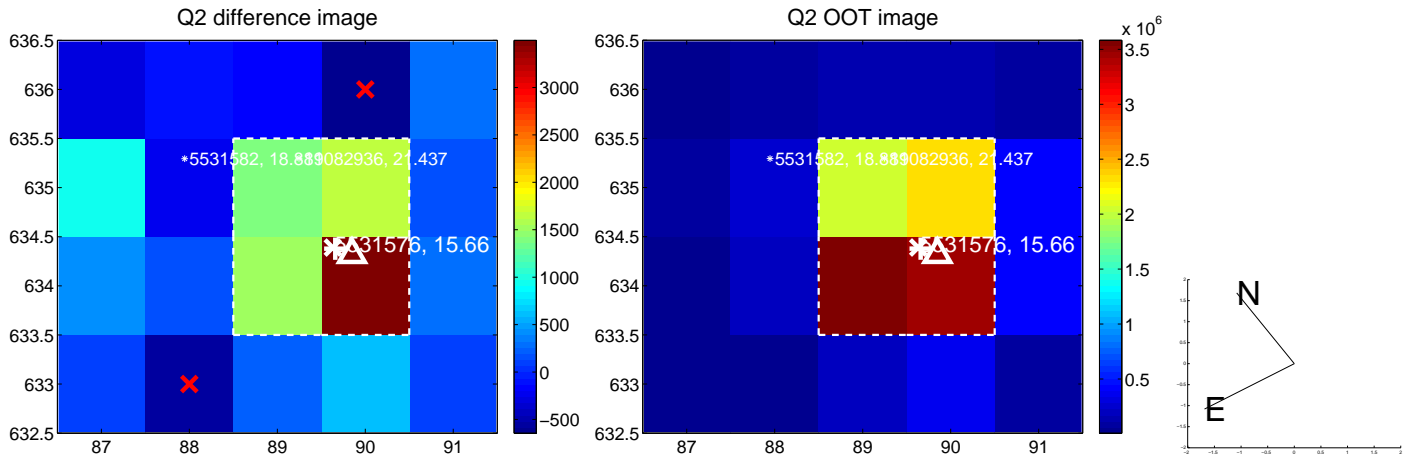
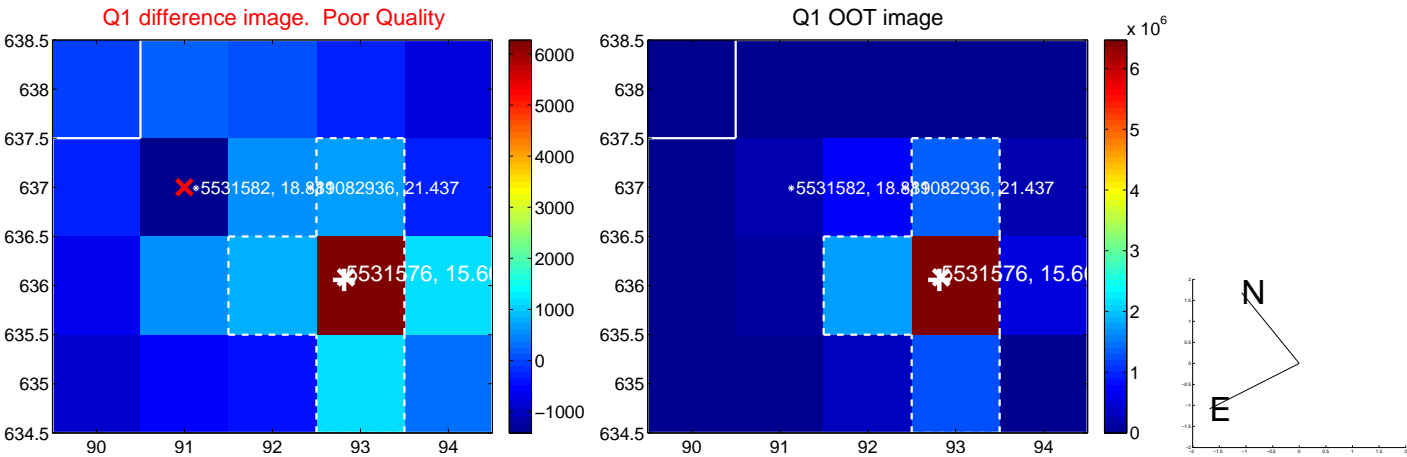
The direct PRF centroid is offset from the target star catalog position by about 0.08 arcsec

| | Distance in arcsec | Distance / σ | Δ RA | Δ Dec |
|---|--------------------|---------------------|--------------------|--------------------|
| PRF-fit source offset from OOT | 0.085 ± 0.142 | 0.59 | -0.048 ± 0.114 | -0.070 ± 0.153 |
| PRF-fit source offset from KIC position | 0.176 ± 0.166 | 1.06 | -0.043 ± 0.109 | -0.171 ± 0.167 |
| photometric centroid source offset | 0.28 ± 0.34 | 0.82 | -0.21 ± 0.35 | 0.18 ± 0.33 |

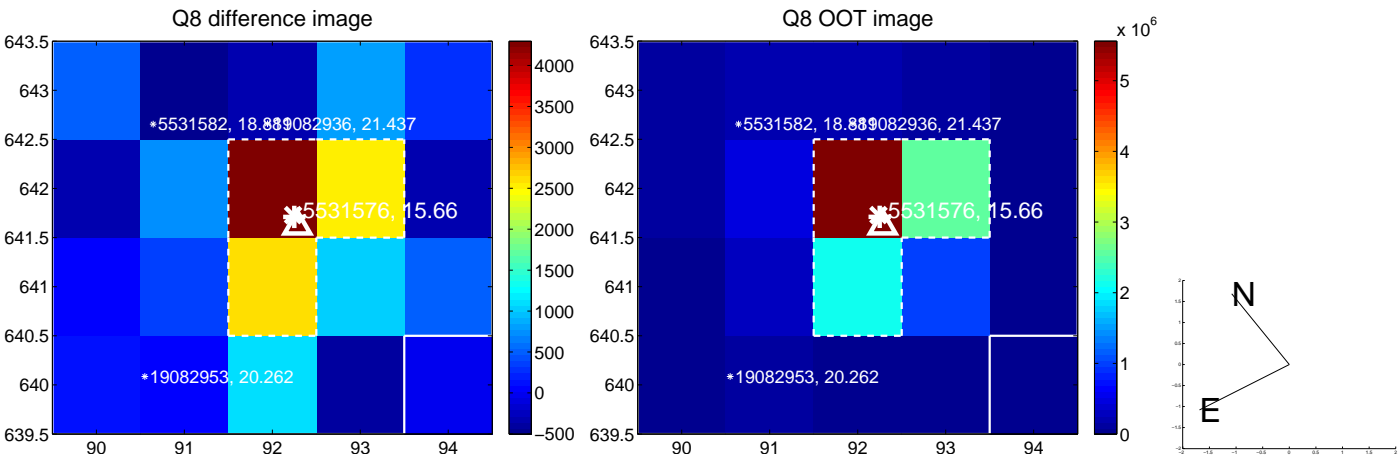
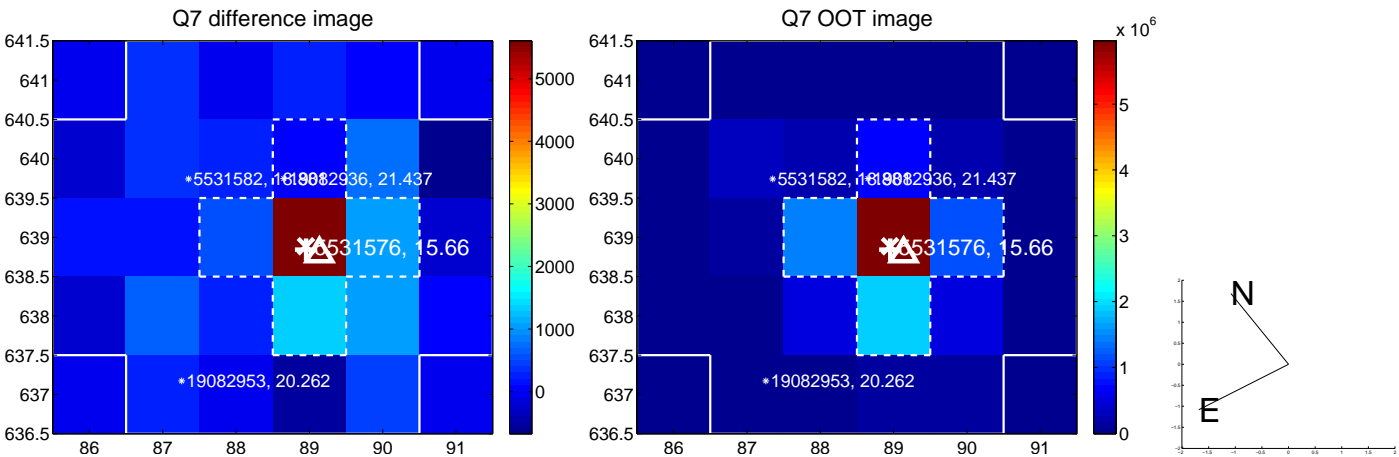
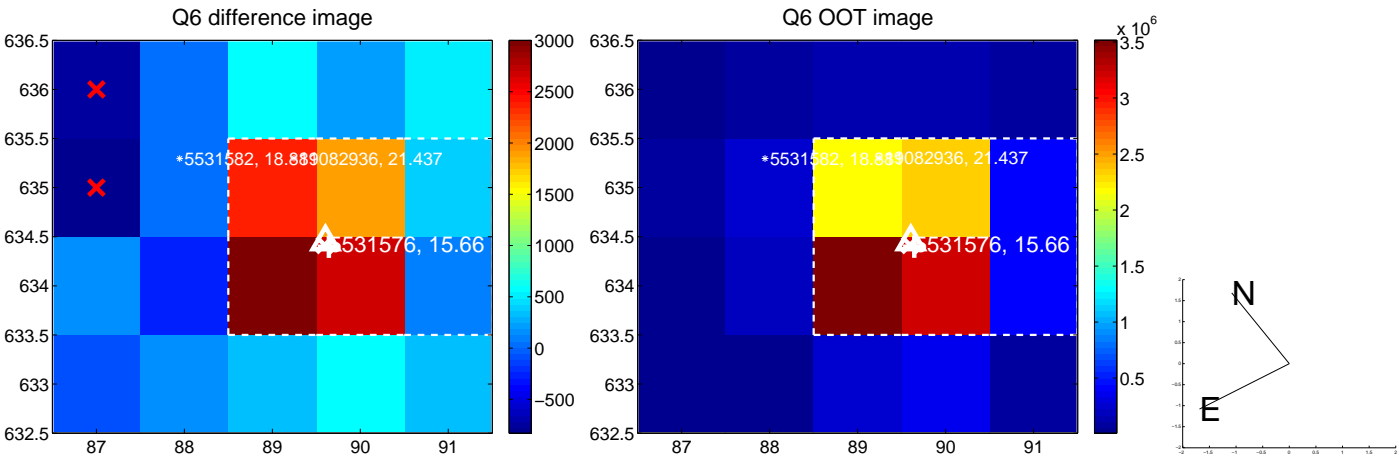
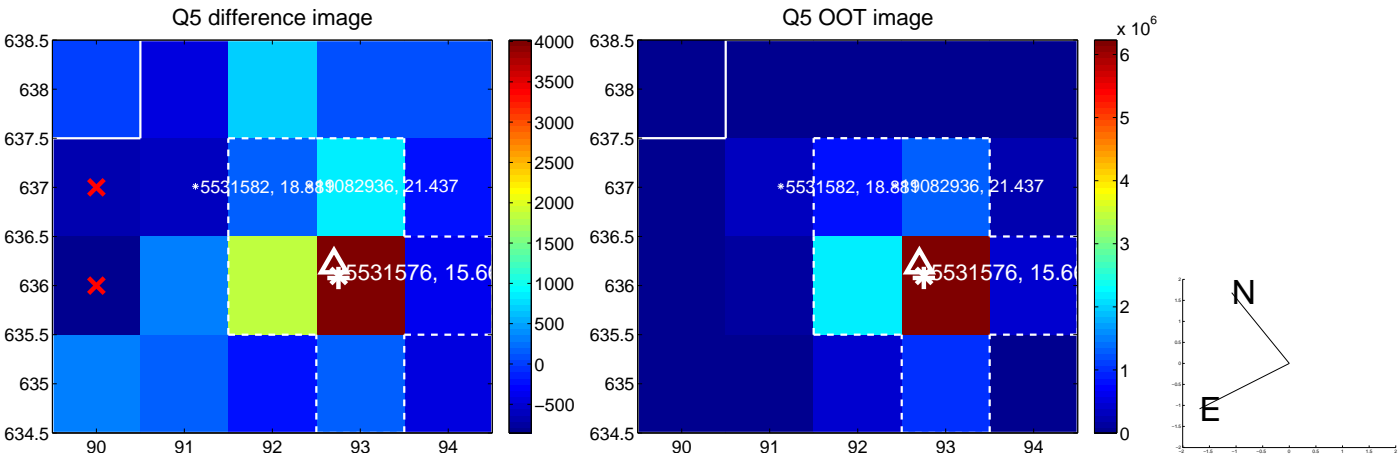


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses:** good quarterly centroid offsets; **Vermillion crosses:** bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- σ uncertainty. Blue circle: three-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

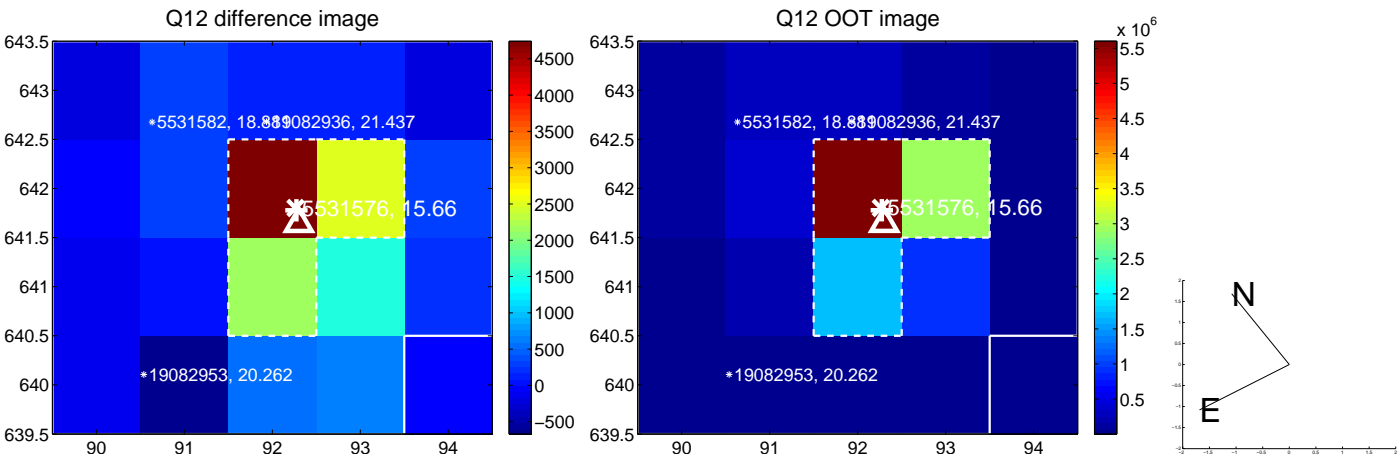
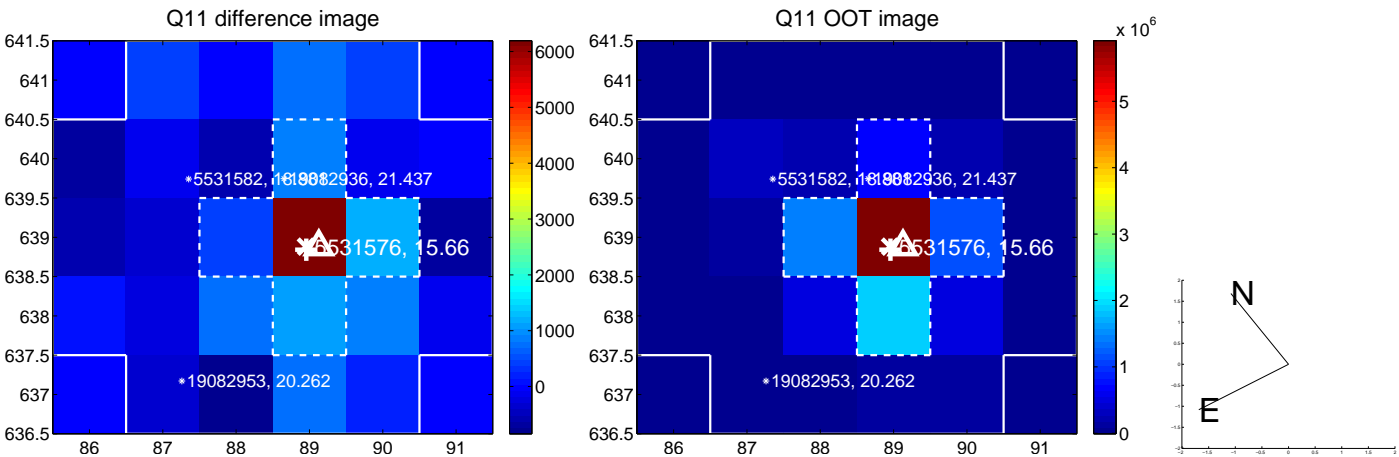
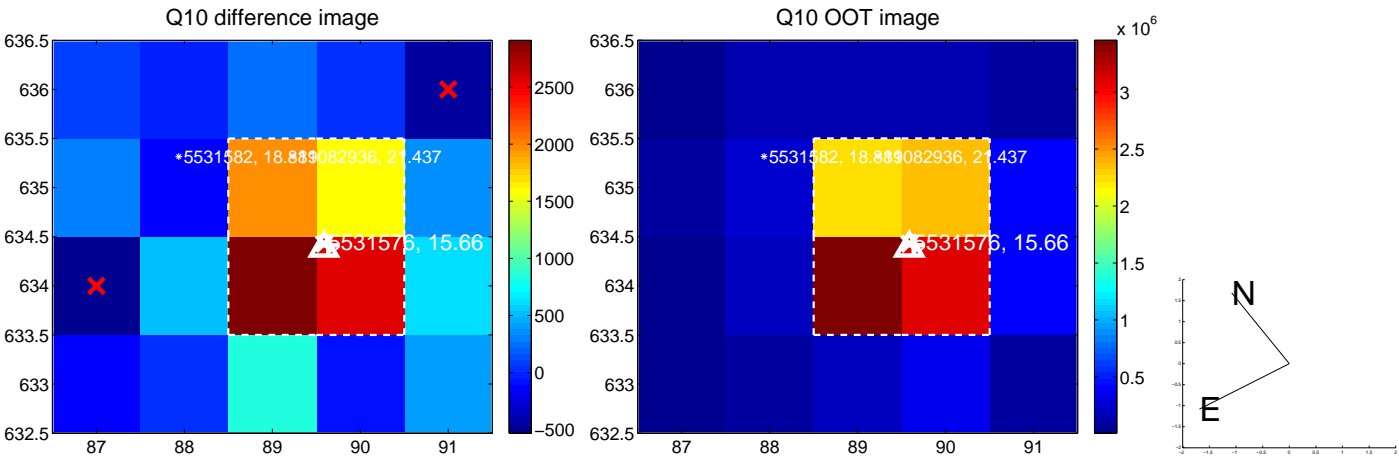
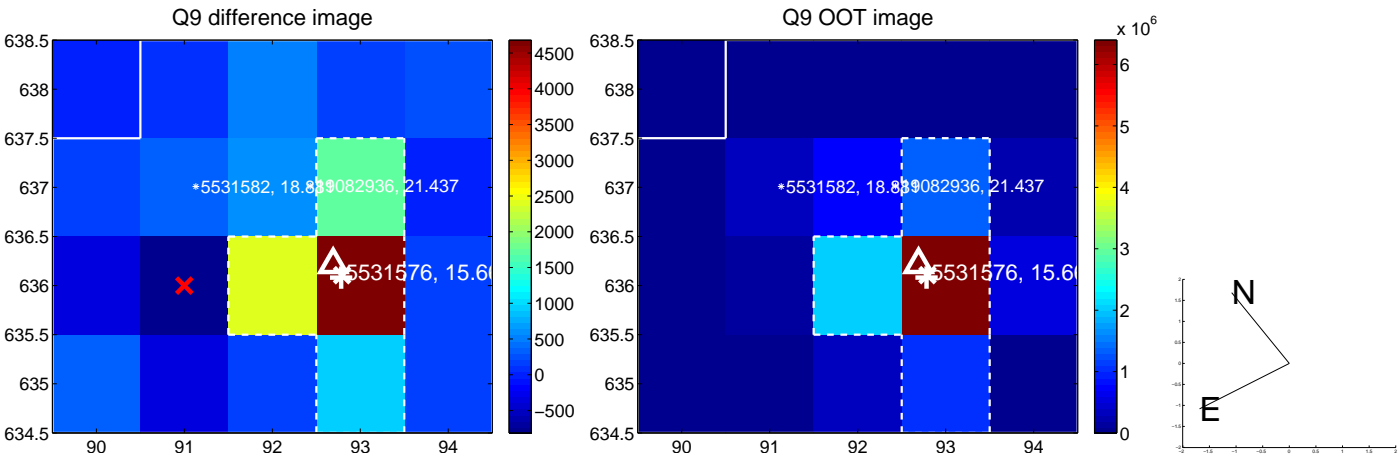
white \times : KIC target position; +: OOT centroid; \triangle : difference centroid. red \times : large negative pixel value.



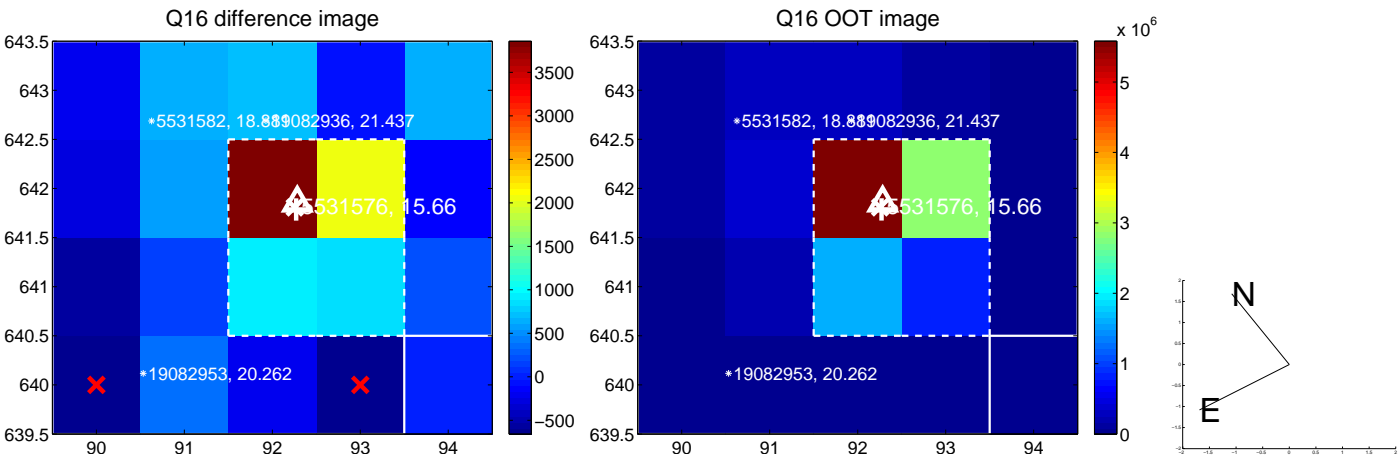
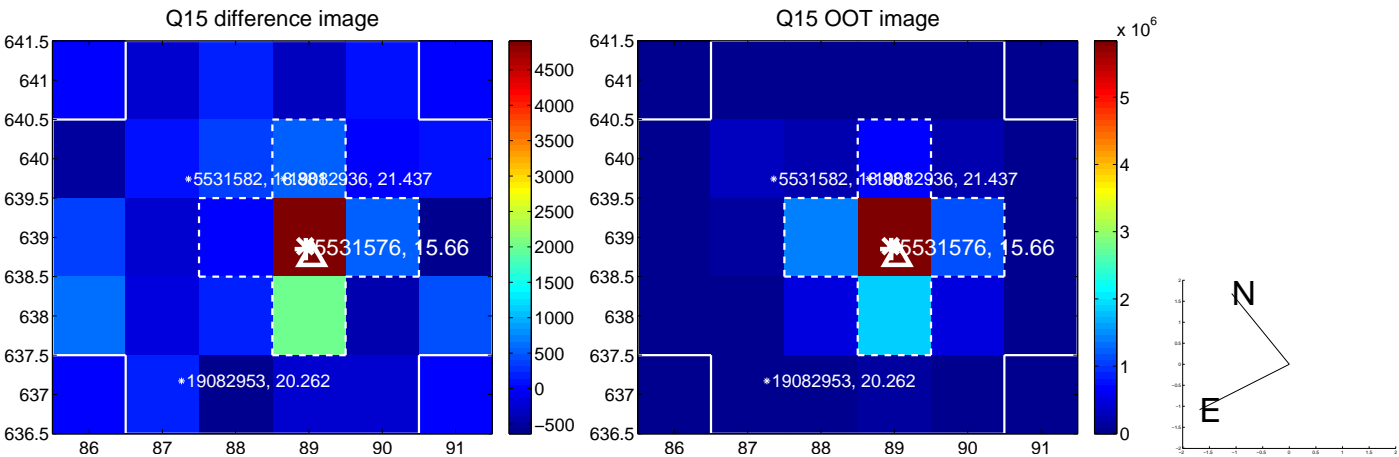
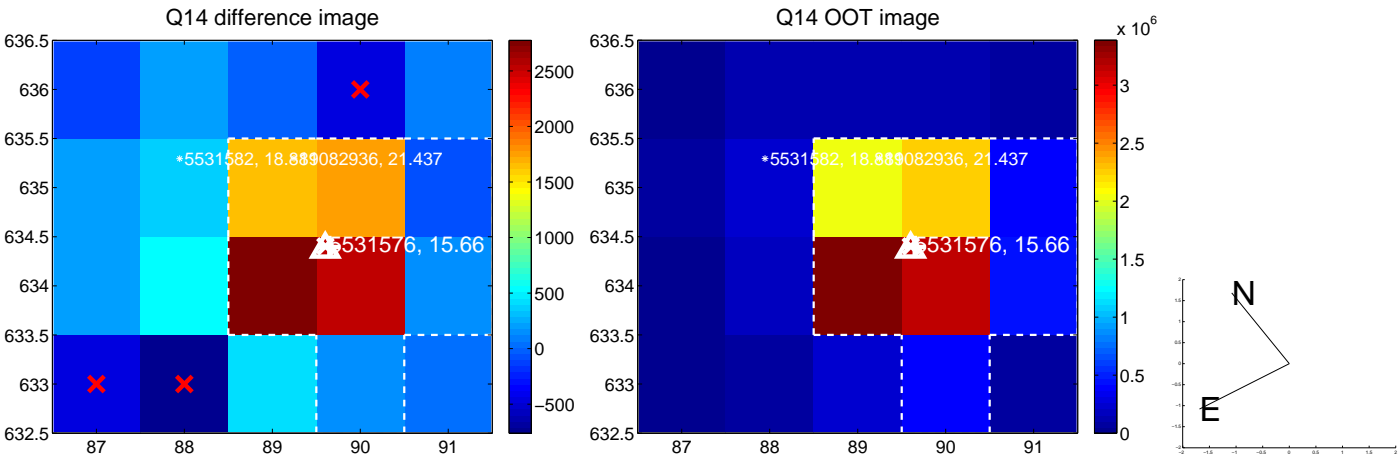
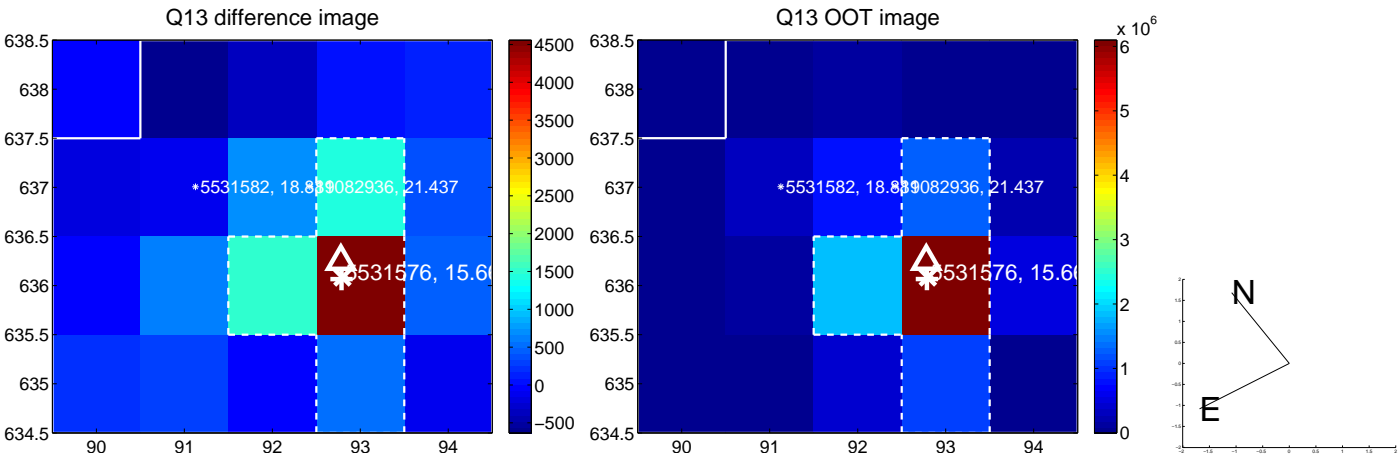
white \times : KIC target position; +: OOT centroid; \triangle : difference centroid. red \times : large negative pixel value.



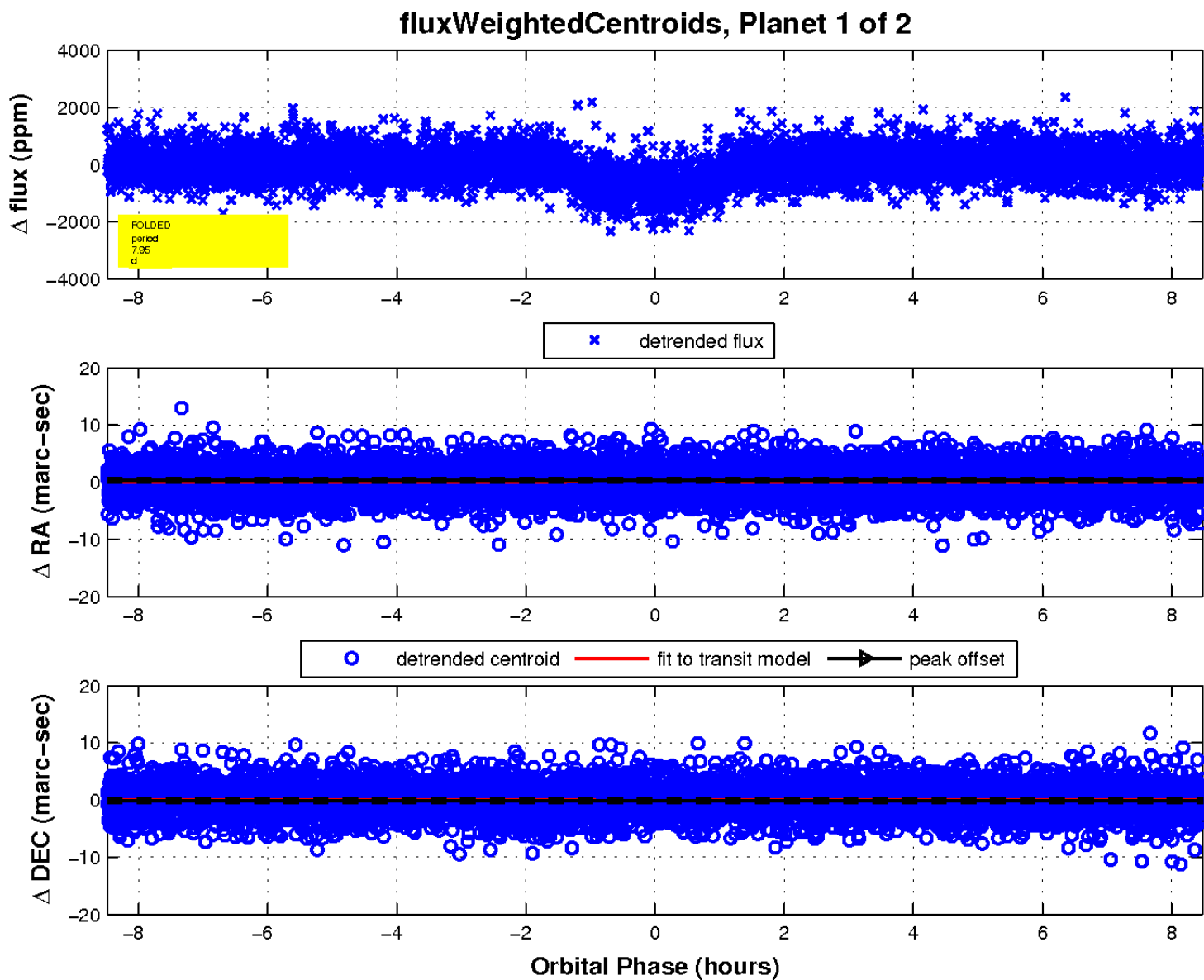
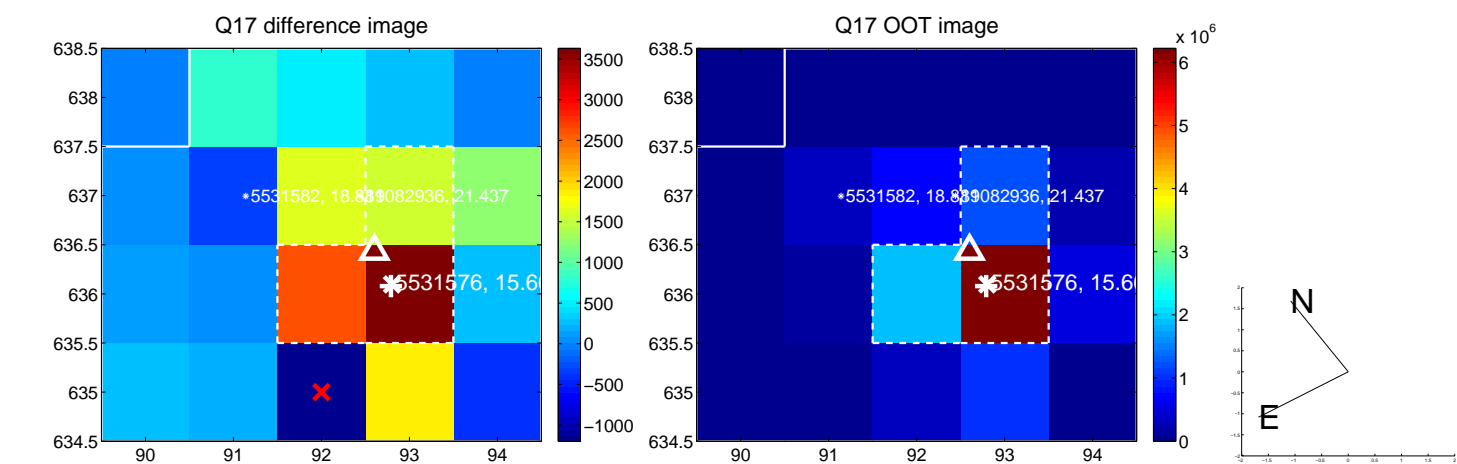
white \times : KIC target position; +: OOT centroid; \triangle : difference centroid. red \times : large negative pixel value.



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

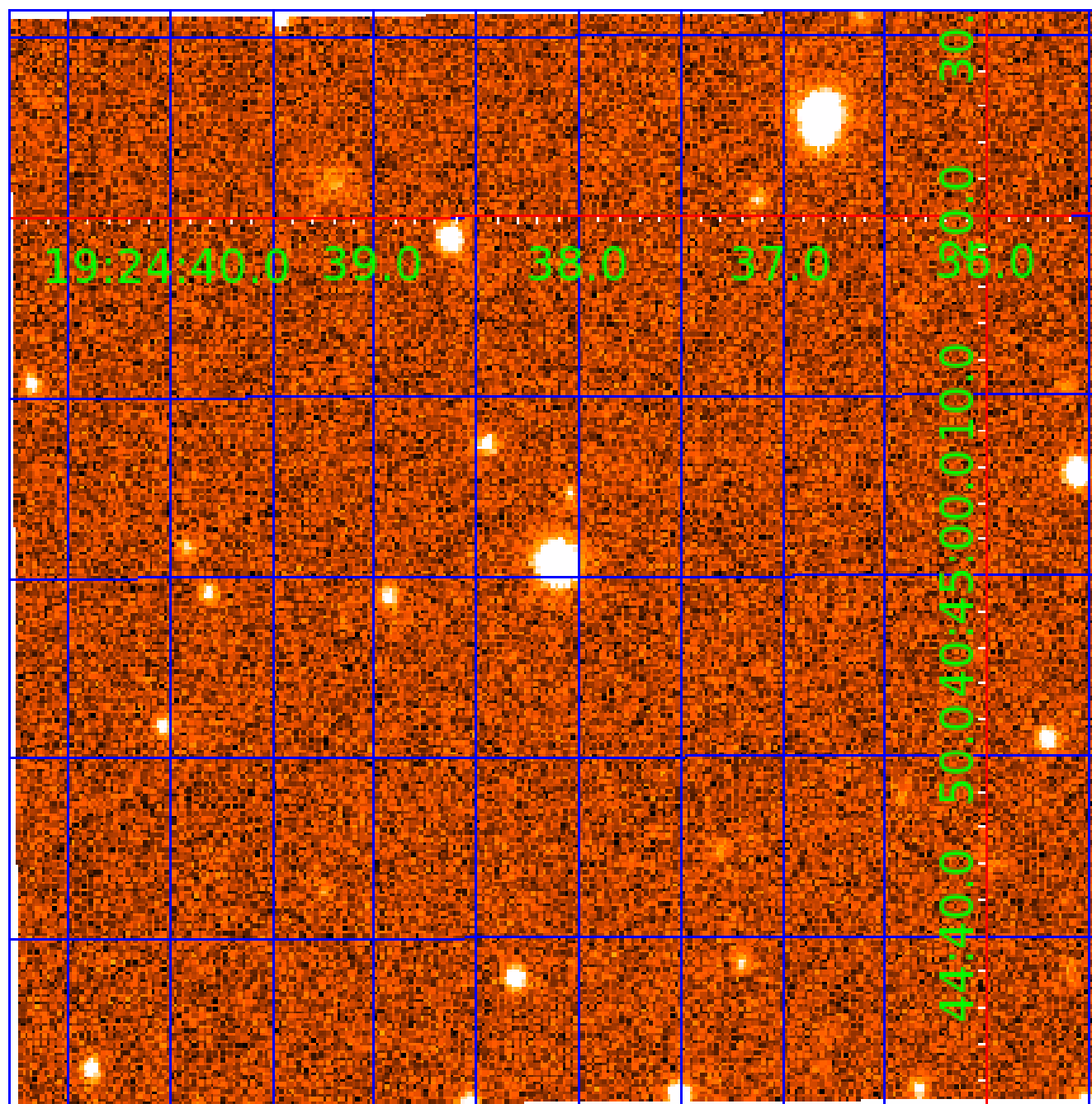


white \times : KIC target position; $+$: OOT centroid; \triangle : difference centroid. red \times : large negative pixel value.



UKIRT Image

Declination



KIC 005531576

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}) |
|--------------|----------|---------|---------------|--------------|-------------|------------------|------|------|-----------------------------|-----------------|------------------------|------------------------|
| 005531576-01 | OBS | 0837.01 | 7.953543 | 134.894264 | 869.3 | 2.828 | 31.9 | 35.4 | 0.78 | 4768 | 2.69 | 55.44 |
| 005531576-02 | OBS | 0837.02 | 4.144517 | 131.783966 | 371.2 | 2.538 | 18.5 | 20.4 | 0.78 | 4768 | 1.83 | 132.22 |

Robovetter Results

| TCE | Run Type | Disp | Score | N | S | C | E | Comments |
|--------------|----------|------|-------|---|---|---|---|------------|
| 005531576-01 | OBS | PC | 1.00 | 0 | 0 | 0 | 0 | NO_COMMENT |
| 005531576-02 | 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 for comment definitions.

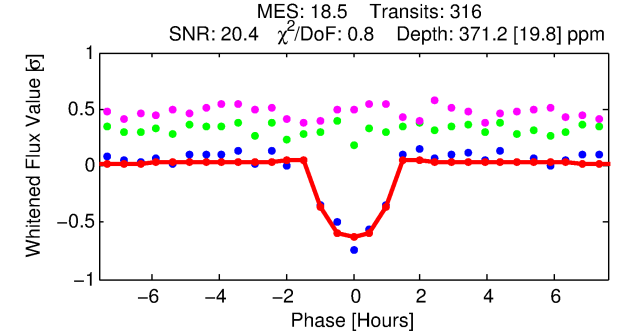
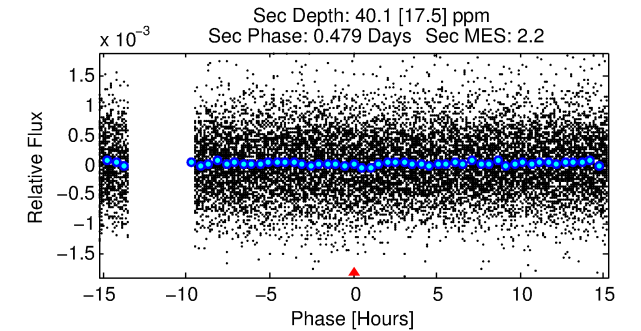
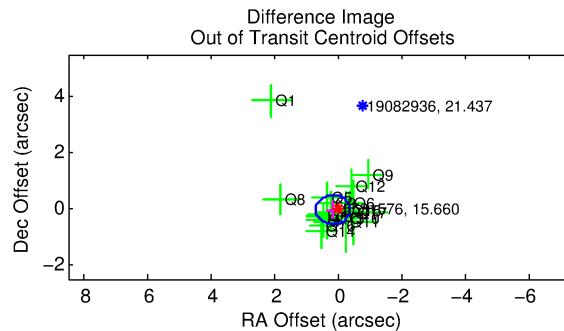
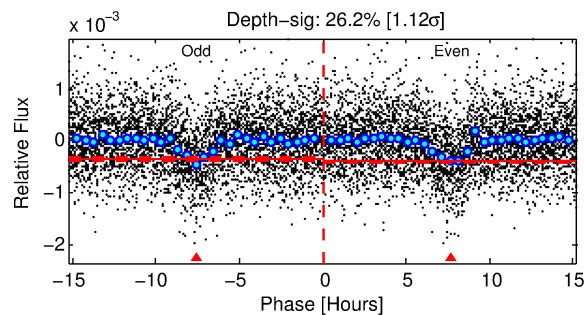
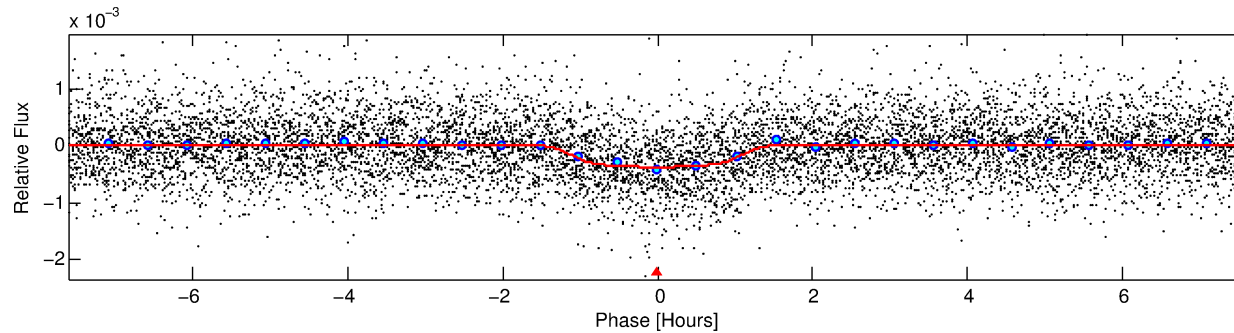
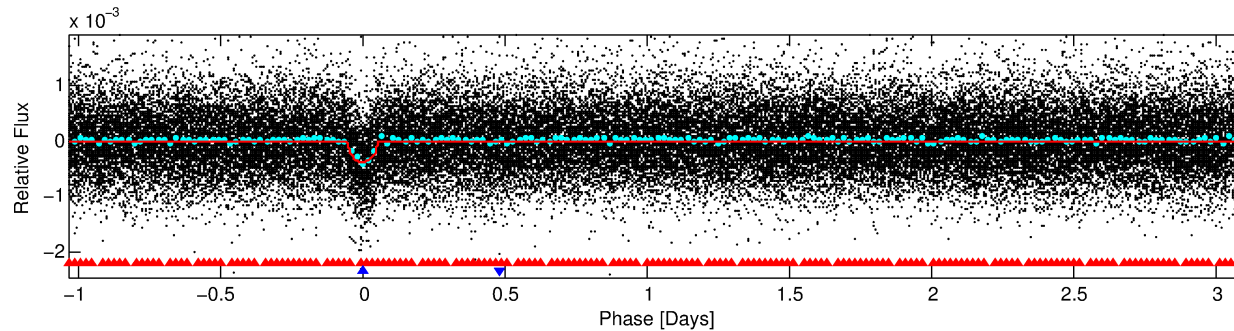
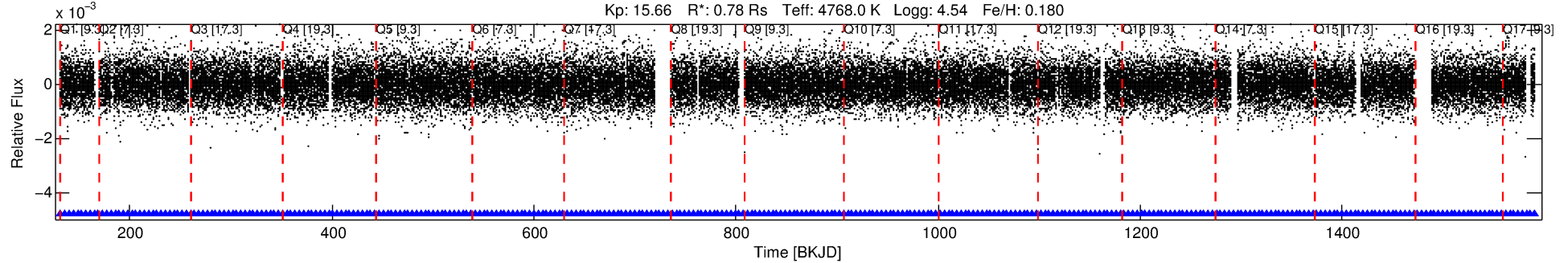
Ephemeris Match Information For 005531576-02

No Significant Match Found

DV One-Page Summary

KIC: 5531576 Candidate: 2 of 2 Period: 4.145 d
KOI: K00837.02 Name: Kepler-240b Corr: 0.966

Kp: 15.66 R*: 0.78 Rs Teff: 4768.0 K Logg: 4.54 Fe/H: 0.180



DV Fit Results:

Period = 4.14452 [0.00001] d
Epoch = 131.7840 [0.0021] BKJD
Rp/R* = 0.0215 [0.0068]
a/R* = 6.28 [7.11]
b = 0.89 [0.27]
Seff = 132.22 [15.77]
Teq = 865 [26] K
Rp = 1.83 [0.59] Re
a = 0.0461 [0.0028] AU
Ag = 14.01 [10.79] [1.21σ]
Teffp = 2586 [497] K [3.46σ]

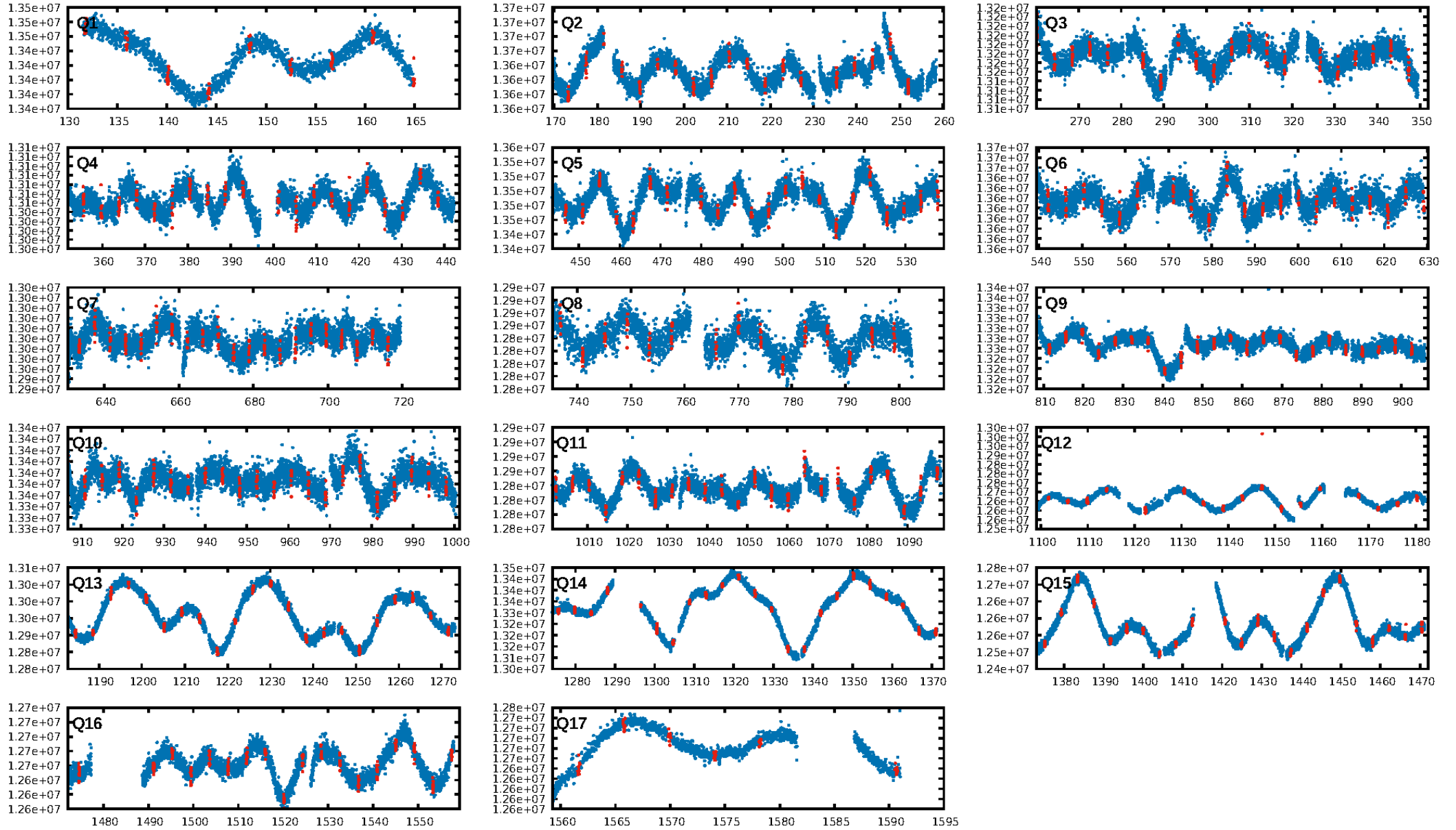
DV Diagnostic Results:

ShortPeriod-sig: N/A
LongPeriod-sig: 100.0% [24.06σ]
ModelChiSquare2-sig: N/A
ModelChiSquareGof-sig: N/A
Bootstrap-pfa: 1.11e-72
RollingBand-fgt: 1.00 [301/301]
GhostDiagnostic-chr: 2.386
Centroid-sig: 99.7%
Centroid-so: 0.193 arcsec [0.32σ]
OotOffset-rm: 0.172 arcsec [0.98σ]
KicOffset-rm: 0.216 arcsec [1.23σ]
OotOffset-st: 4/4/4/5 [17]
KicOffset-st: 4/4/4/5 [17]
DiffImageQuality-fgm: 0.94 [16/17]
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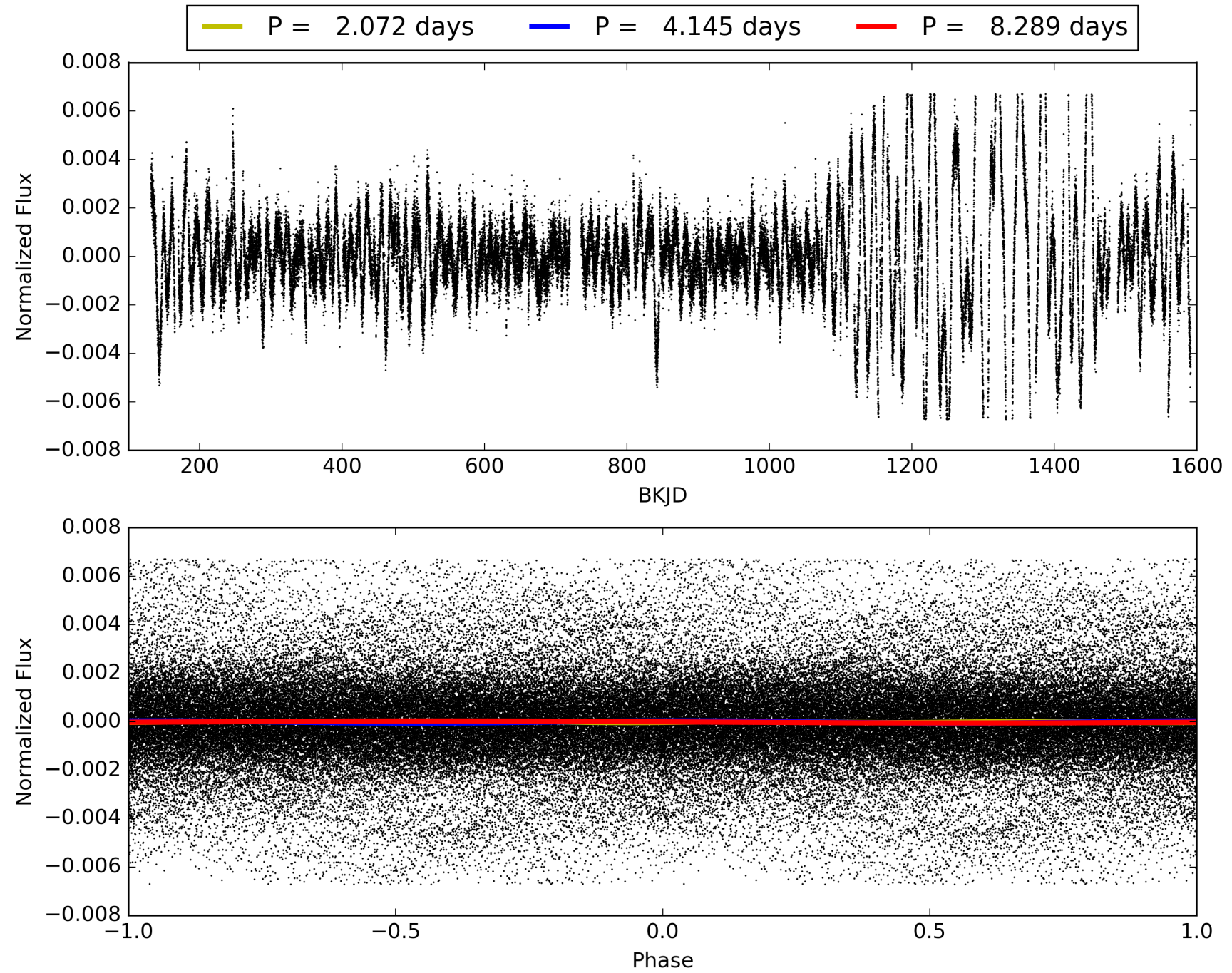
Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 31-Jan-2016 11:16:30 Z

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

TCE 005531576-02, PDC Light Curves

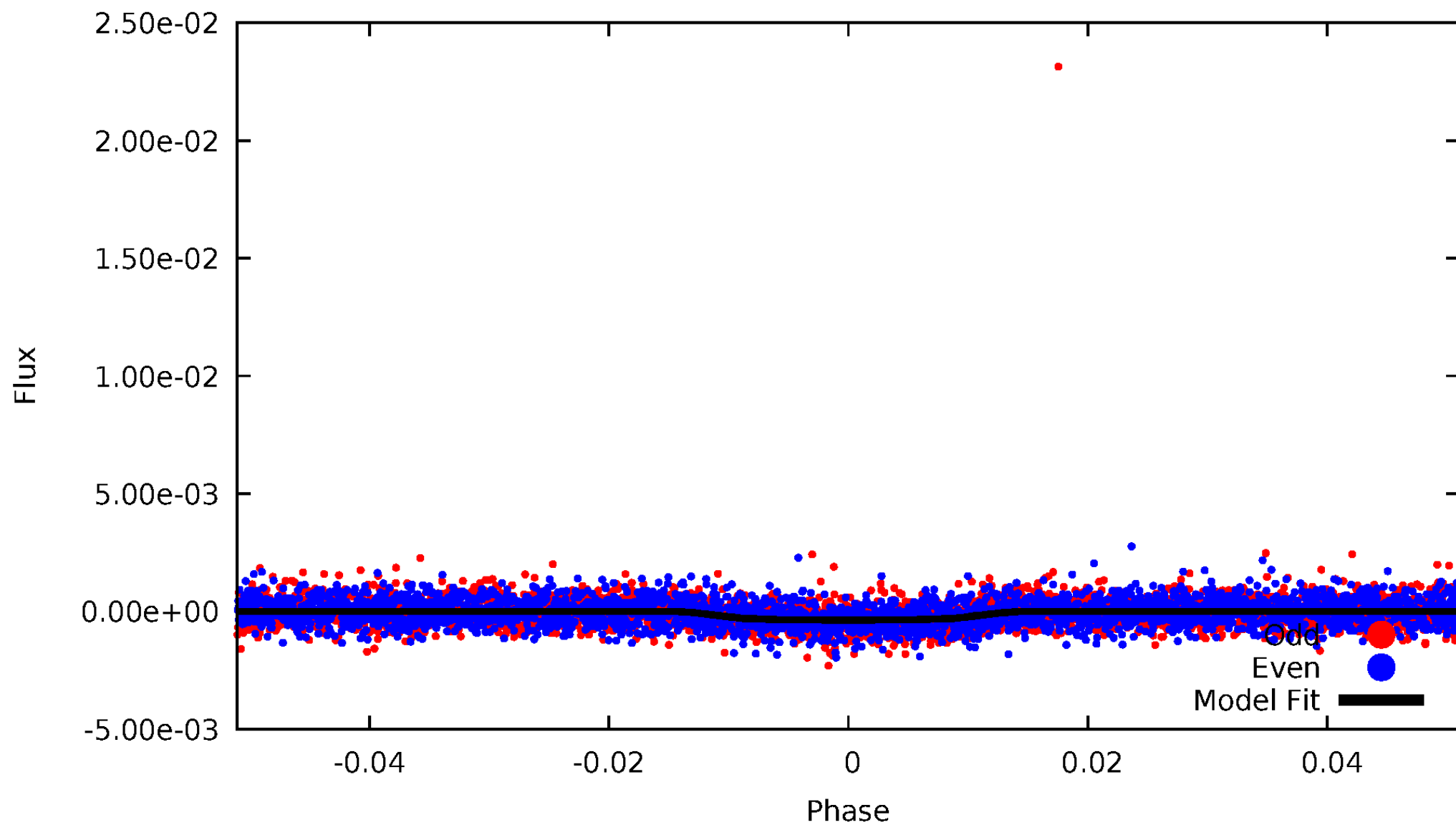


TCE 005531576-02



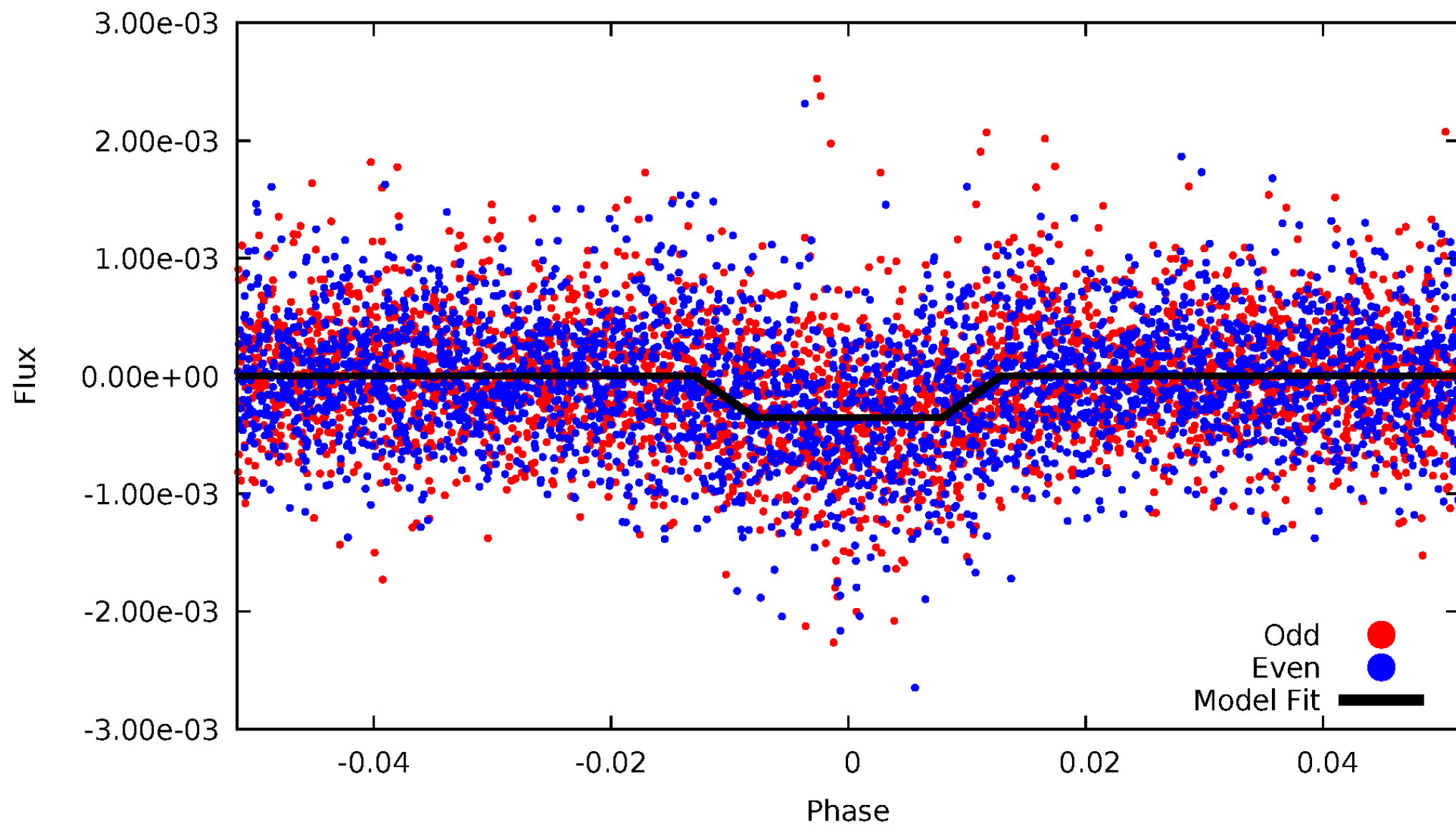
DV Odd/Even

TCE 005531576-02



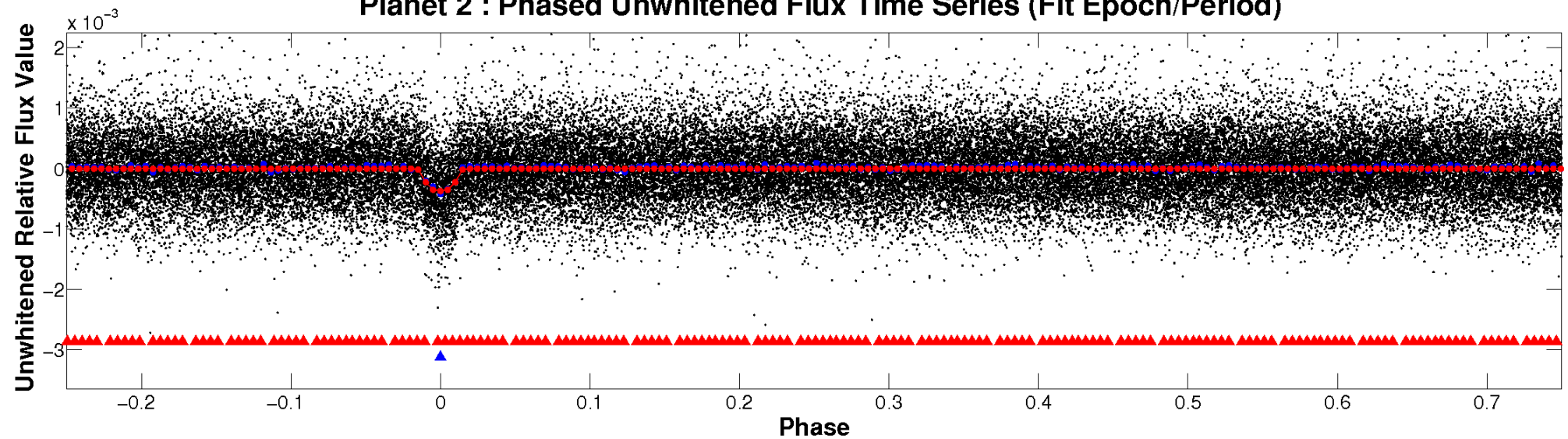
ALT Odd/Even

TCE 005531576-02

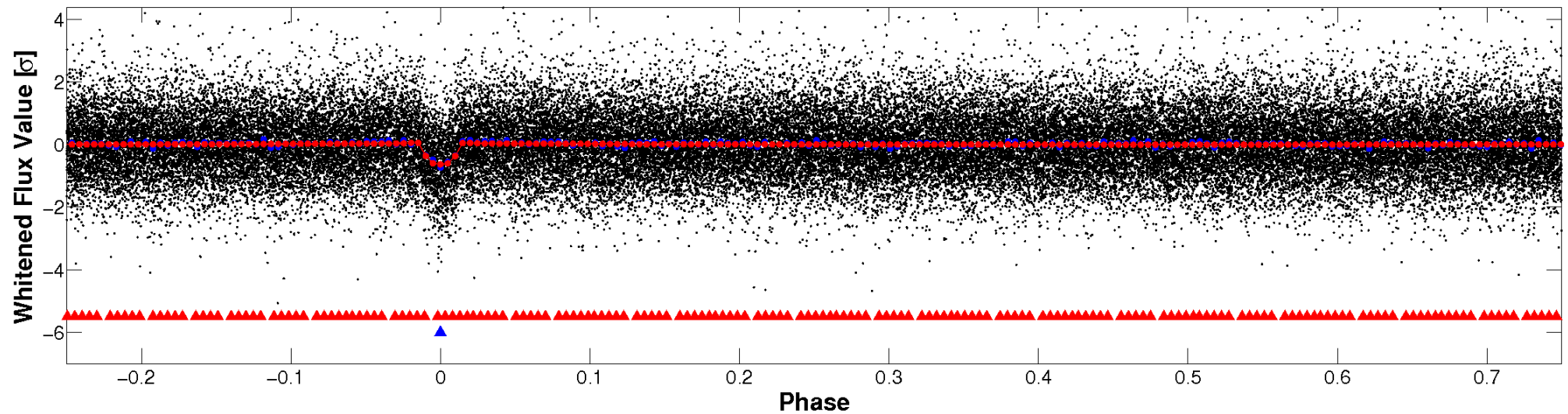


Non-Whitened Vs. Whitened Light Curve

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

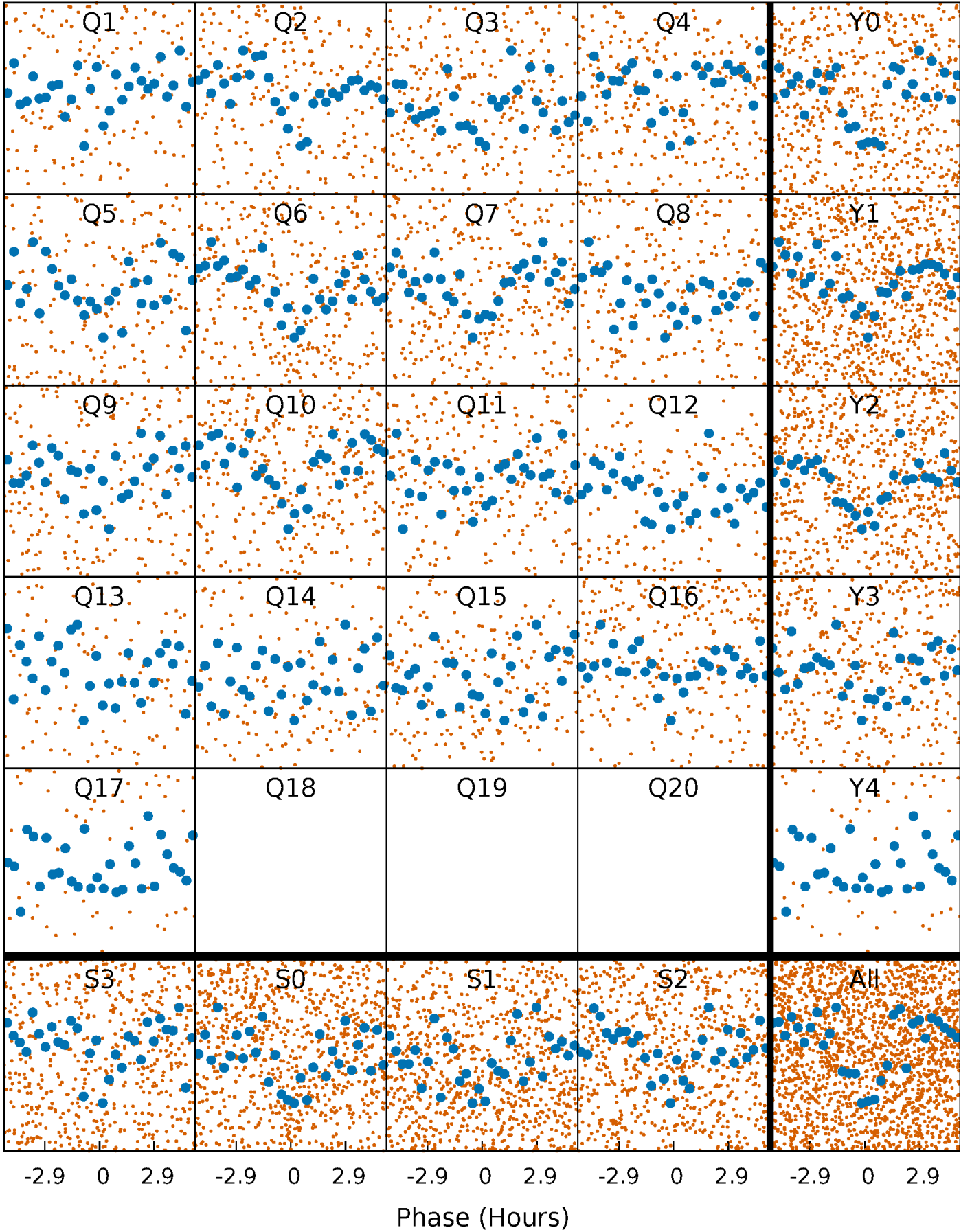


Planet 2 : Phased Whitened Flux Time Series (Fit Epoch/Period)



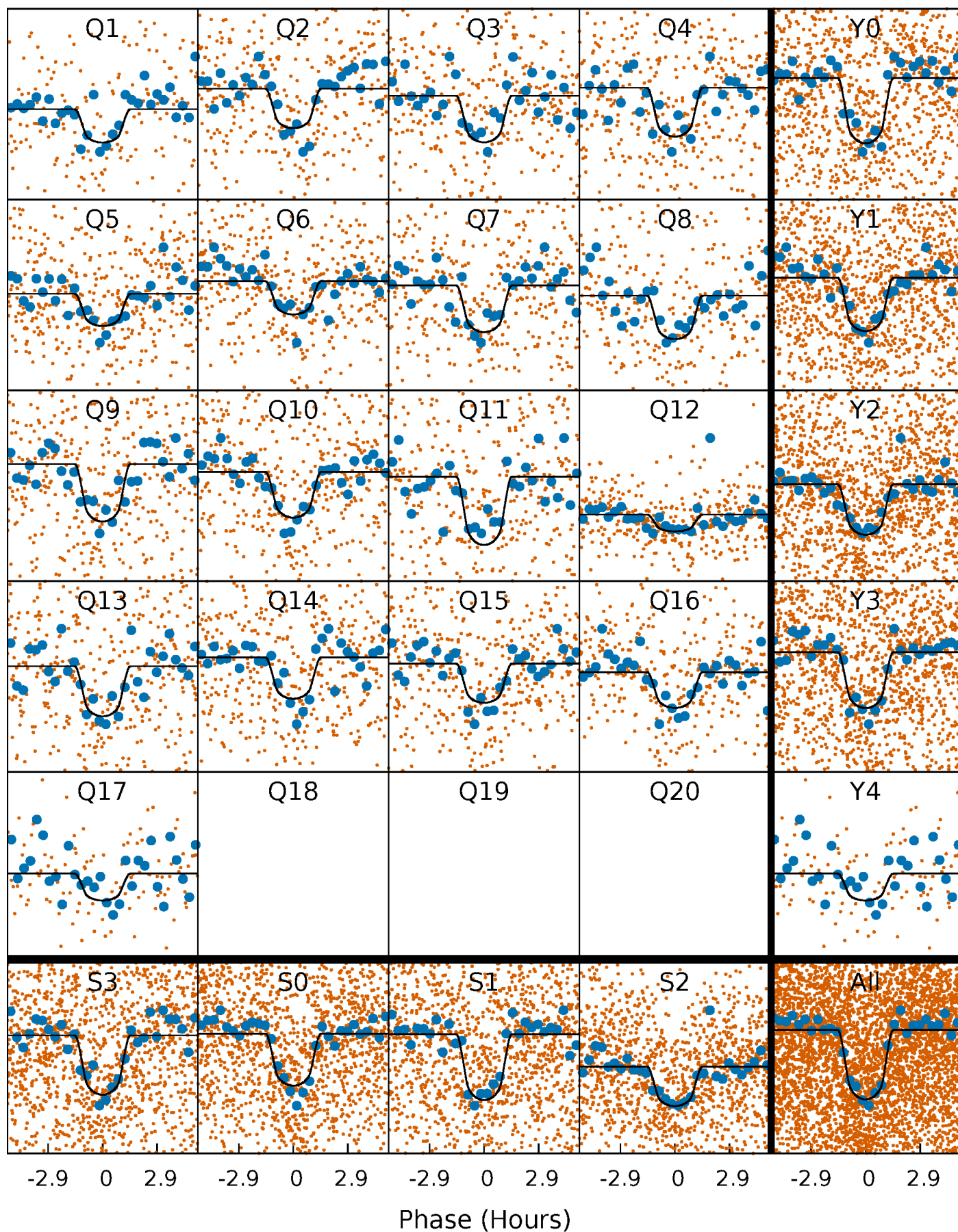
PDC Quarter-Phased Transit Curves

TCE 005531576-02 P= 4.144517 Days $T_0=131.783966$ (BKJD)



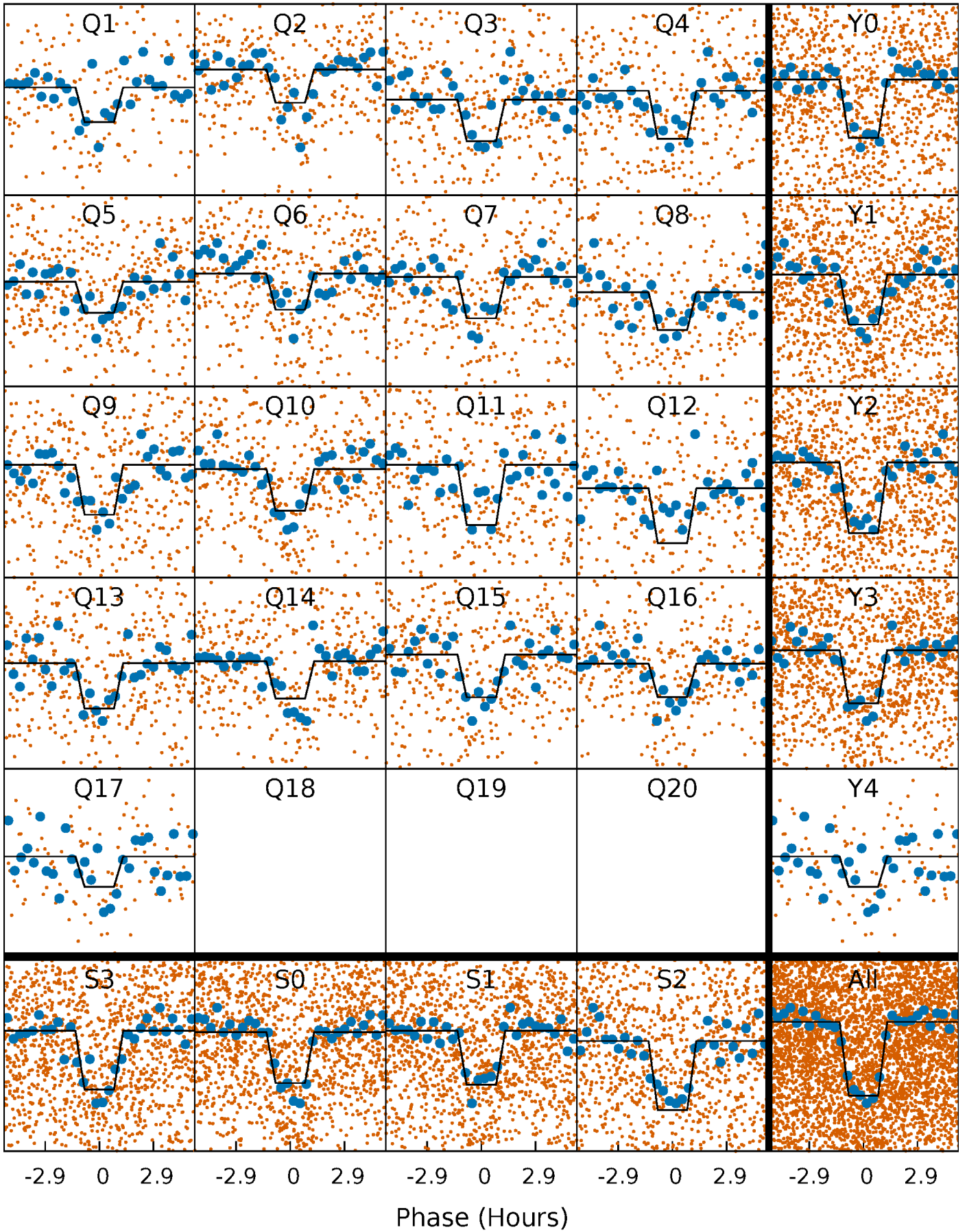
DV Quarter-Phased Transit Curves

TCE 005531576-02 P= 4.144517 Days $T_0=131.783966$ (BKJD)



Alt. Detrend Quarter-Phased Transit Curves

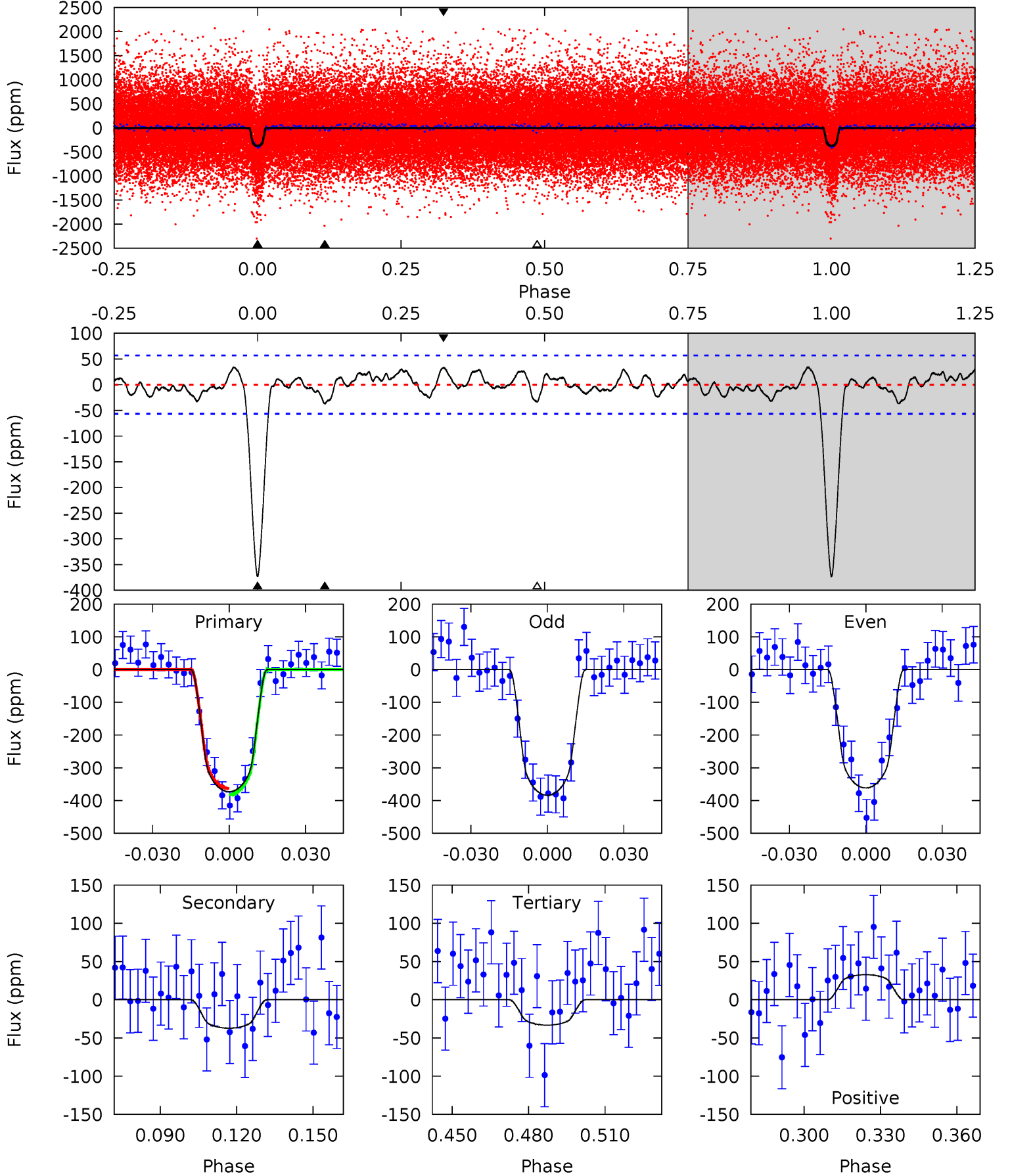
TCE 005531576-02 P= 4.144526 Days $T_0=131.781693$ (BKJD)



DV Model-Shift Uniqueness Test

005531576-02, P = 4.144517 Days, E = 127.639449 Days

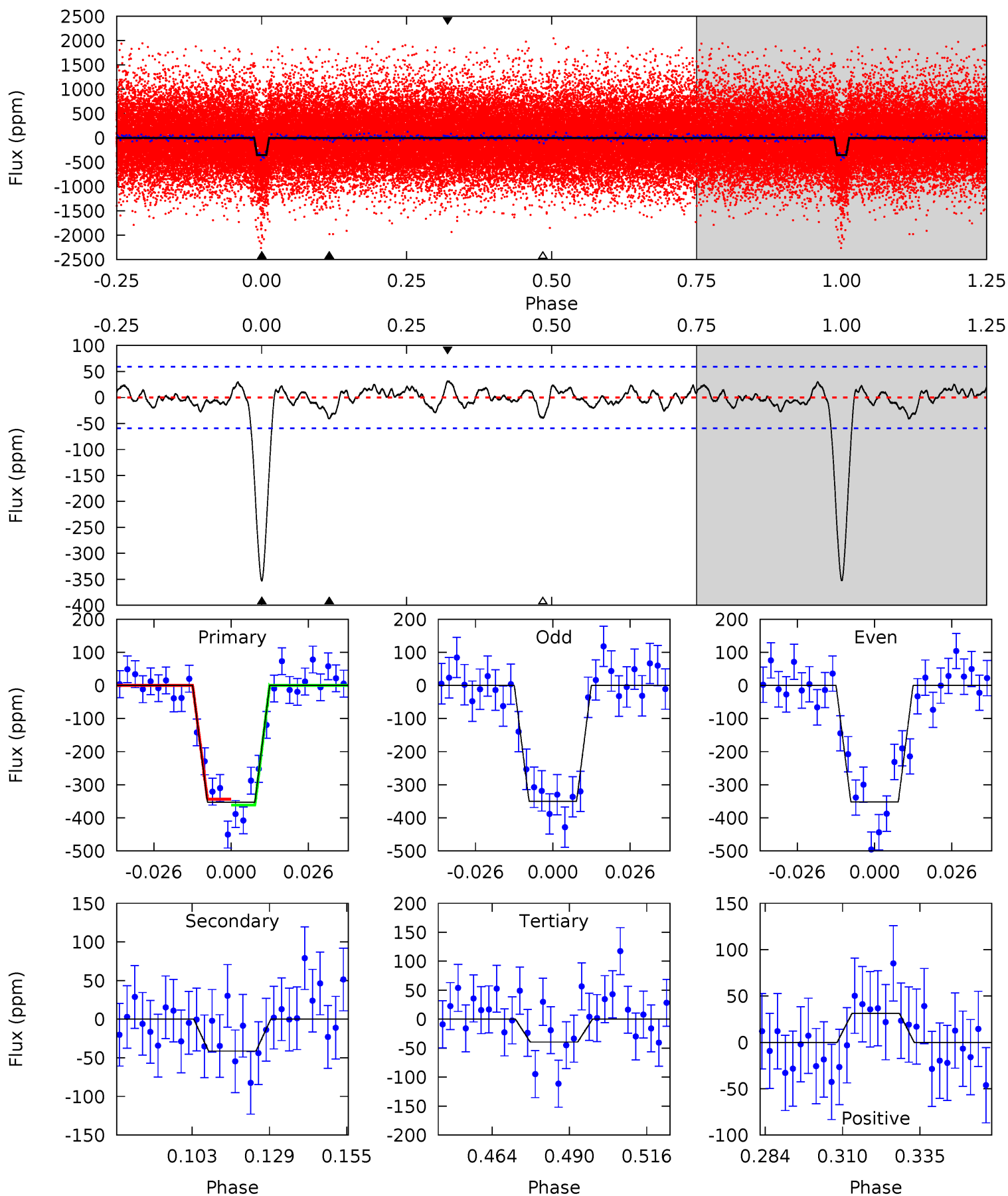
| Pri | Sec | Ter | Pos | FA ₁ | FA ₂ | F _{Red} | Pri-Ter | Pri-Pos | Sec-Ter | Sec-Pos | Odd-Evn | DMM | Shape | TAT |
|------|------|------|------|-----------------|-----------------|------------------|---------|---------|---------|---------|---------|------|-------|------|
| 31.5 | 3.15 | 2.81 | 2.77 | 4.81 | 2.17 | 1.24 | 28.7 | 28.8 | 0.34 | 0.37 | 0.96 | 0.98 | 0.08 | 0.81 |



Alt Model-Shift Uniqueness Test

005531576-02, P = 4.144526 Days, E = 127.637167 Days

| Pri | Sec | Ter | Pos | FA ₁ | FA ₂ | F _{Red} | Pri-Ter | Pri-Pos | Sec-Ter | Sec-Pos | Odd-Evn | DMM | Shape | TAT |
|------|------|------|------|-----------------|-----------------|------------------|---------|---------|---------|---------|---------|------|-------|------|
| 28.8 | 3.37 | 3.22 | 2.55 | 4.84 | 2.23 | 1.06 | 25.6 | 26.3 | 0.15 | 0.81 | 0.06 | 1.01 | 0.08 | 0.71 |



Stellar Parameters For KIC 005531576

| | $T_{\text{eff}}(K)$ | $\log(g)$ | $[\text{Fe}/\text{H}]$ | $R (R_{\odot})$ | $M(M_{\odot})$ | $p_{\star} (\text{g}\cdot\text{cm}^{-3})$ |
|--------|---------------------|---------------------------|---------------------------|---------------------------|---------------------------|---|
| | 4768^{+76}_{-85} | $4.536^{+0.056}_{-0.016}$ | $0.180^{+0.150}_{-0.150}$ | $0.779^{+0.023}_{-0.049}$ | $0.759^{+0.046}_{-0.027}$ | $2.266^{+0.484}_{-0.151}$ |
| | +2%/-2% | +1%/-0% | +83%/-83% | +3%/-6% | +6%/-4% | +21%/-7% |
| Source | SPE90 | SPE90 | SPE90 | DSEP | | |

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

Secondary Eclipse Parameters for KIC 005531576-02 / KOI 0837.02

| Detrend | Depth (ppm) | $R_p (R_{\oplus})$ | $T_{max} (K)$ | $T_{obs} (K)$ | A_{obs} |
|---------|--------------|------------------------|--------------------|----------------------|------------------|
| DV | -37 ± 12 | $1.81^{+0.59}_{-0.56}$ | 1200^{+22}_{-28} | 3087^{+399}_{-306} | 13^{+17}_{-7} |
| Alt. | -41 ± 12 | $1.53^{+0.61}_{-0.55}$ | 1200^{+25}_{-28} | 3296^{+490}_{-369} | 21^{+28}_{-11} |

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

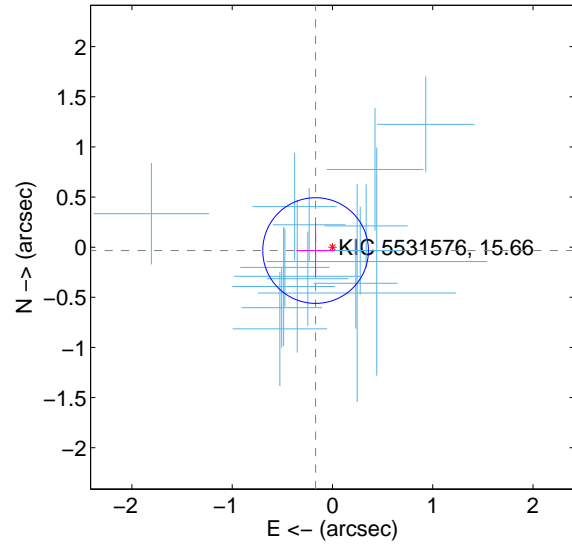
Supplemental centroid analysis for 005531576-02. Kepler magnitude: 15.66. Transit SNR 20.39

There are 16 quarters with good PRF difference image offsets

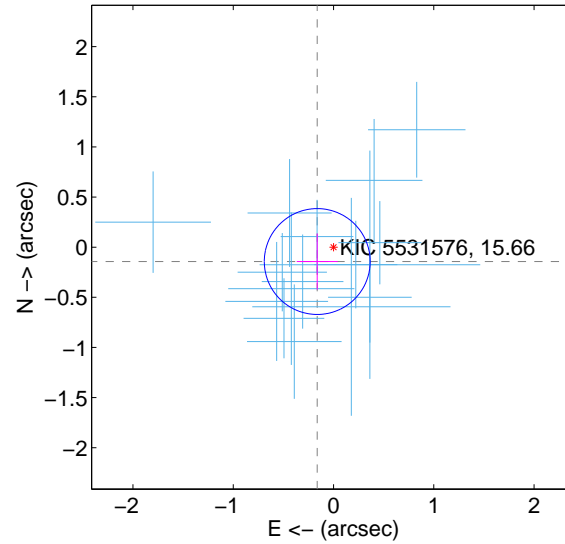
The direct PRF centroid is offset from the target star catalog position by about 0.09 arcsec

| | Distance in arcsec | Distance / σ | Δ RA | Δ Dec |
|---|--------------------|---------------------|-------------------|--------------------|
| PRF-fit source offset from OOT | 0.172 ± 0.176 | 0.98 | 0.168 ± 0.192 | -0.034 ± 0.271 |
| PRF-fit source offset from KIC position | 0.216 ± 0.176 | 1.23 | 0.162 ± 0.204 | -0.143 ± 0.280 |
| photometric centroid source offset | 0.19 ± 0.61 | 0.32 | 0.17 ± 0.61 | 0.09 ± 0.58 |

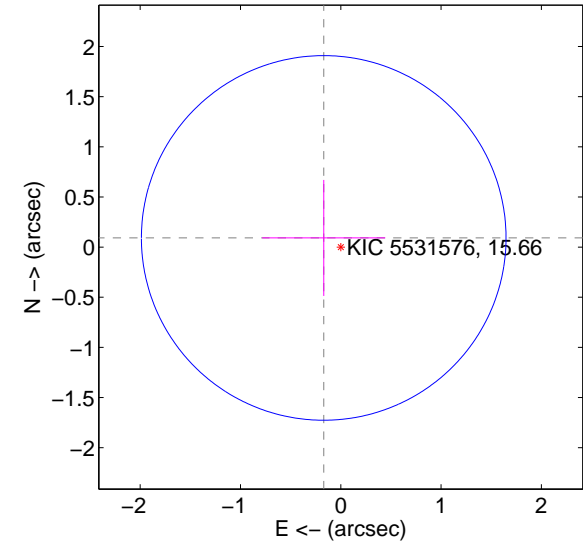
offset from difference PRF-fit to OOT PRF-fit



offset from difference PRF-fit to KIC position

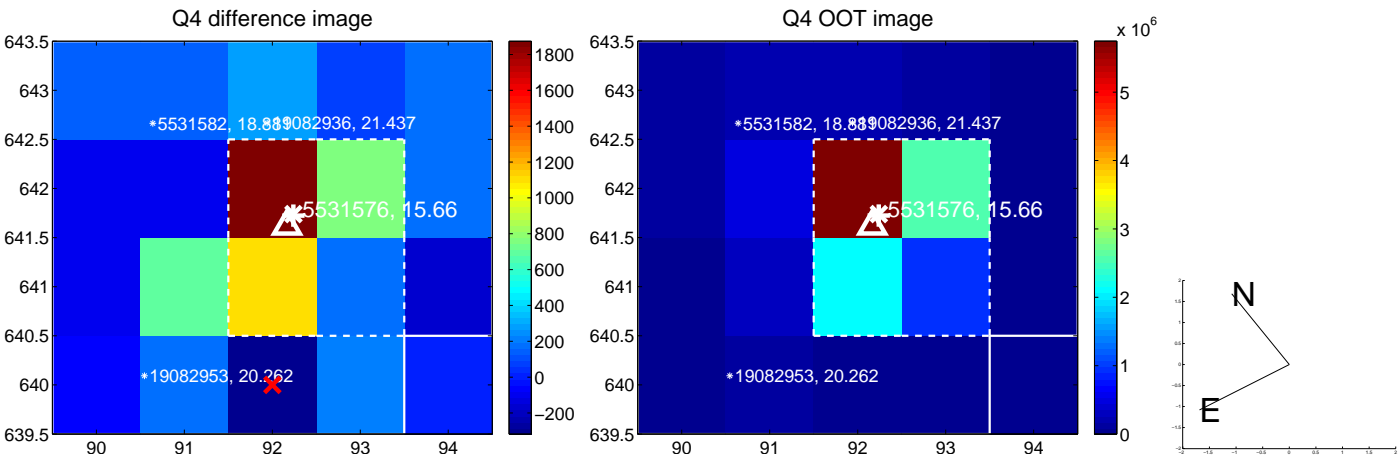
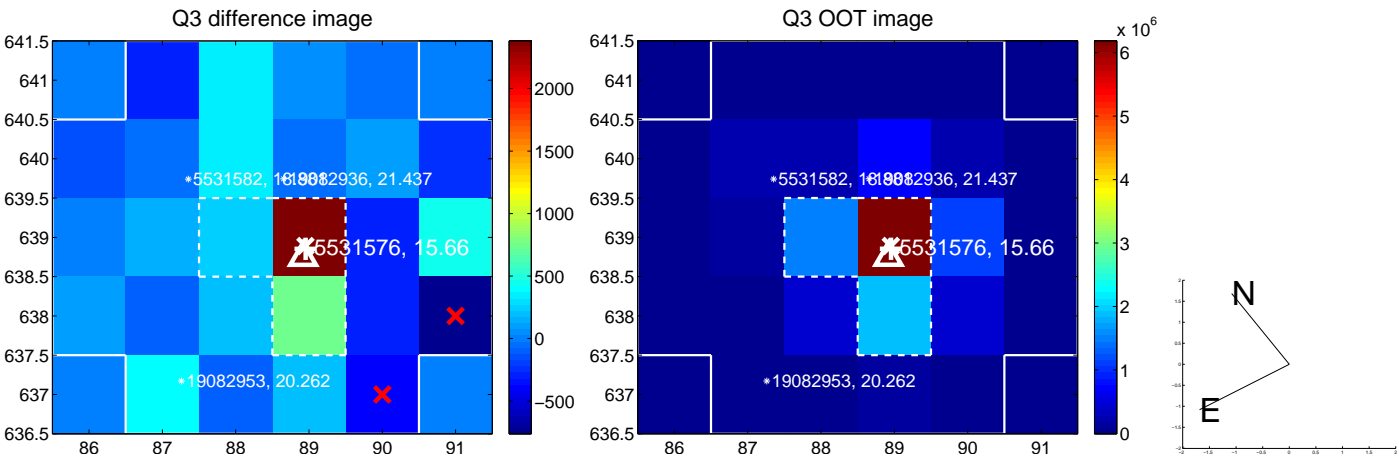
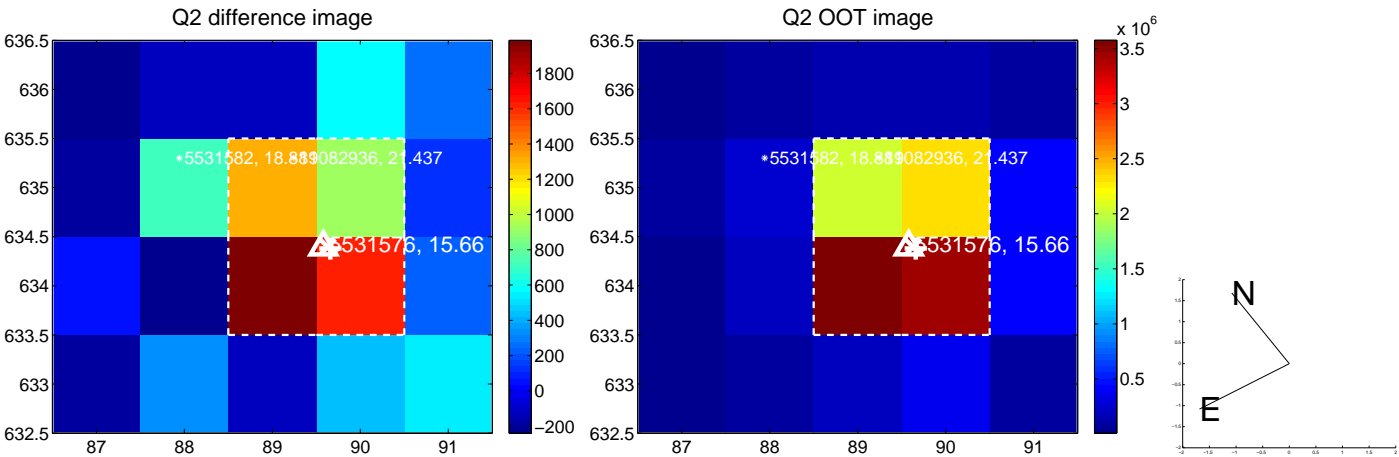
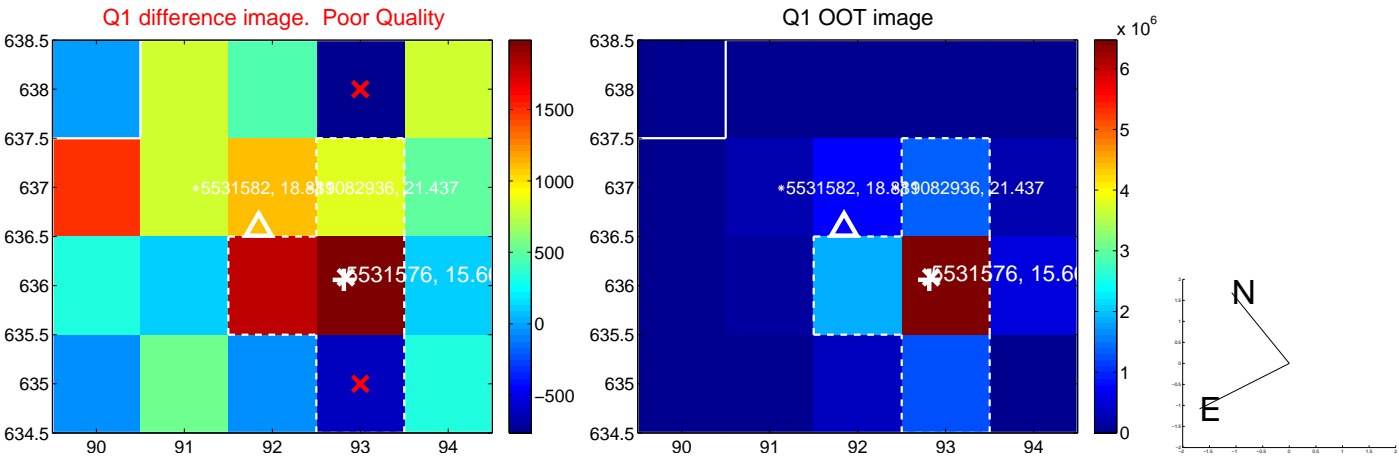


offset from photometric centroids

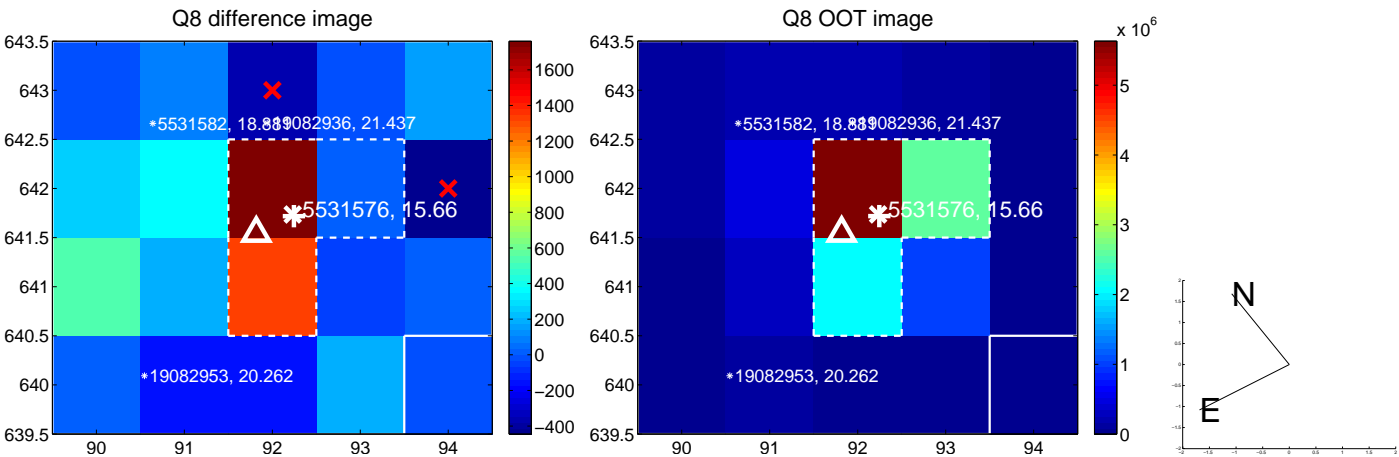
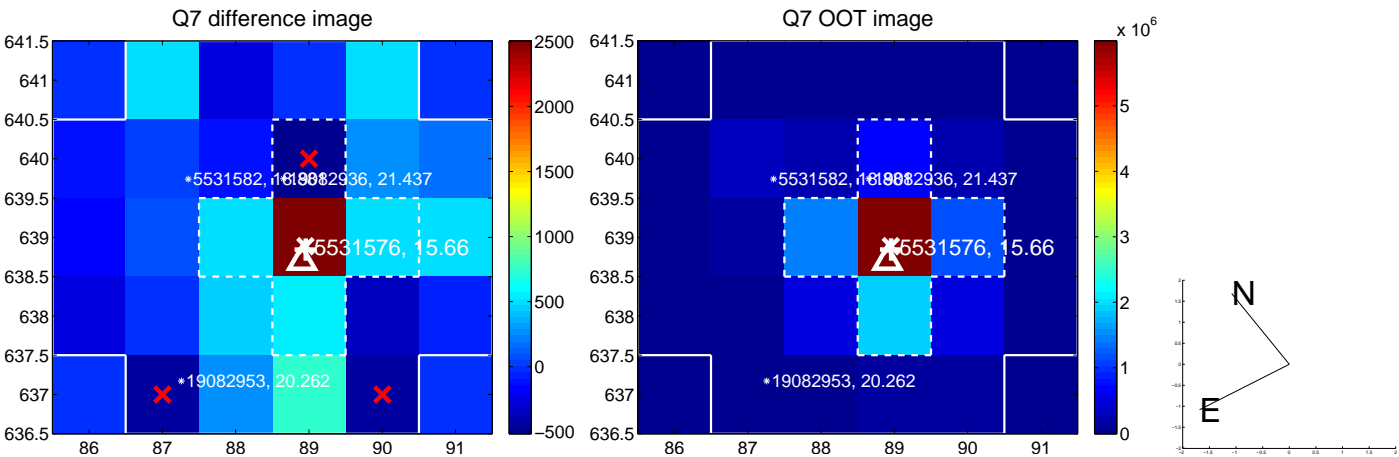
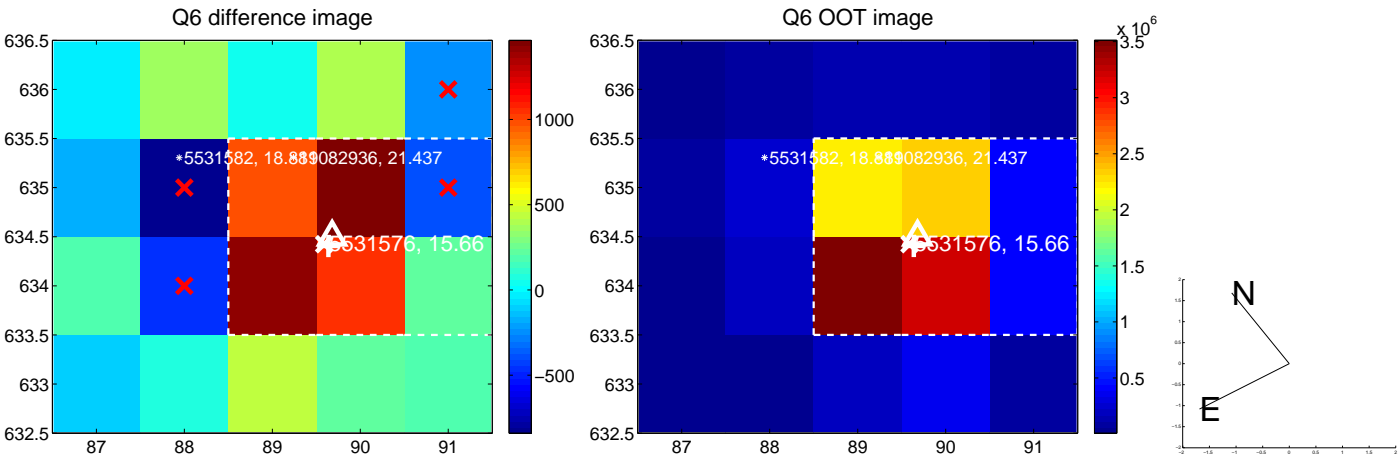
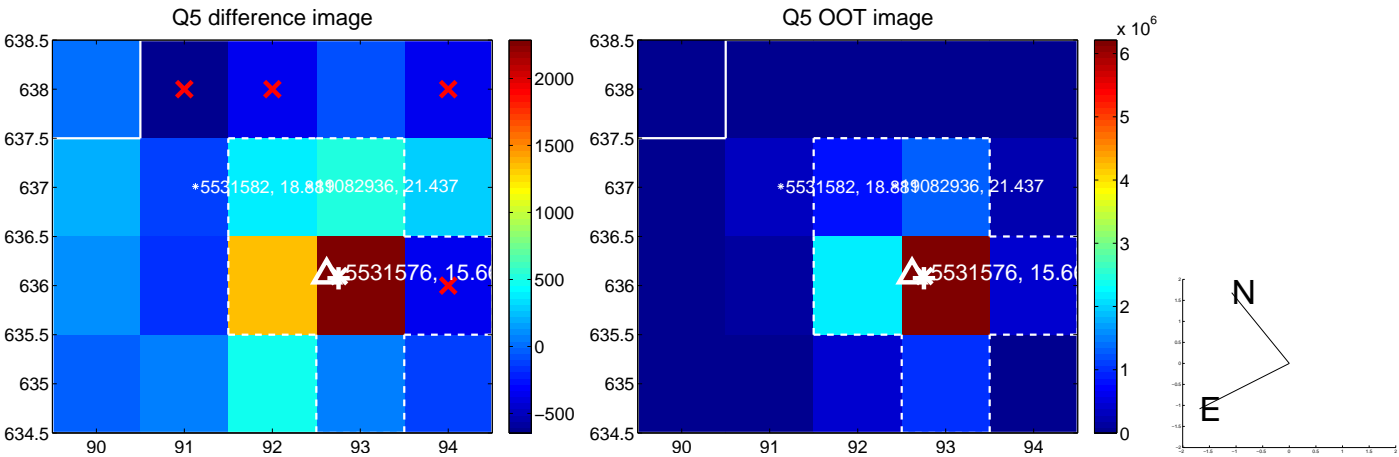


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses:** good quarterly centroid offsets; **Vermillion crosses:** bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- σ uncertainty. Blue circle: three-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

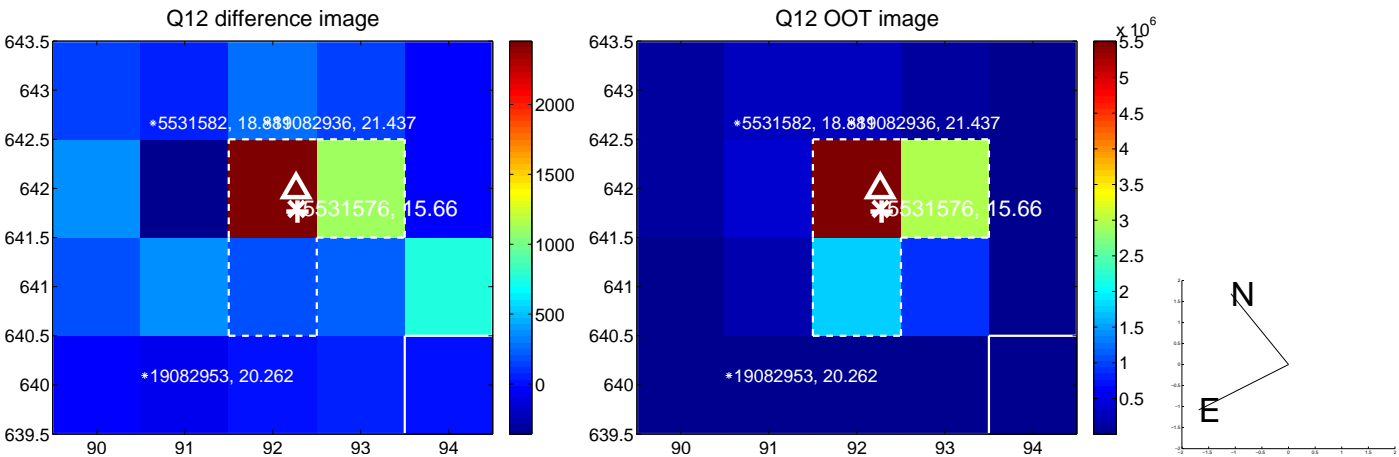
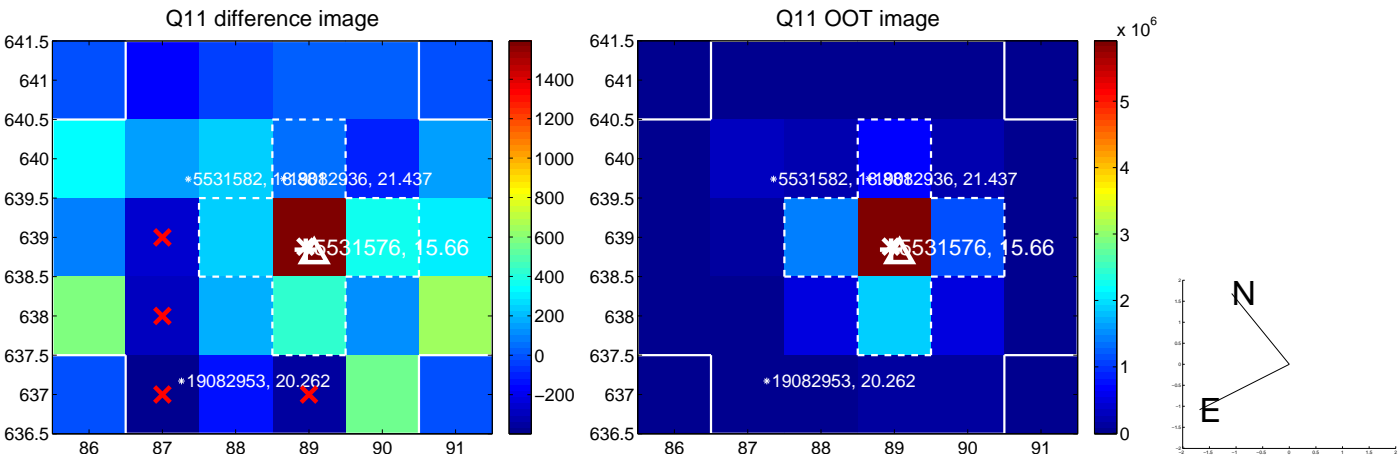
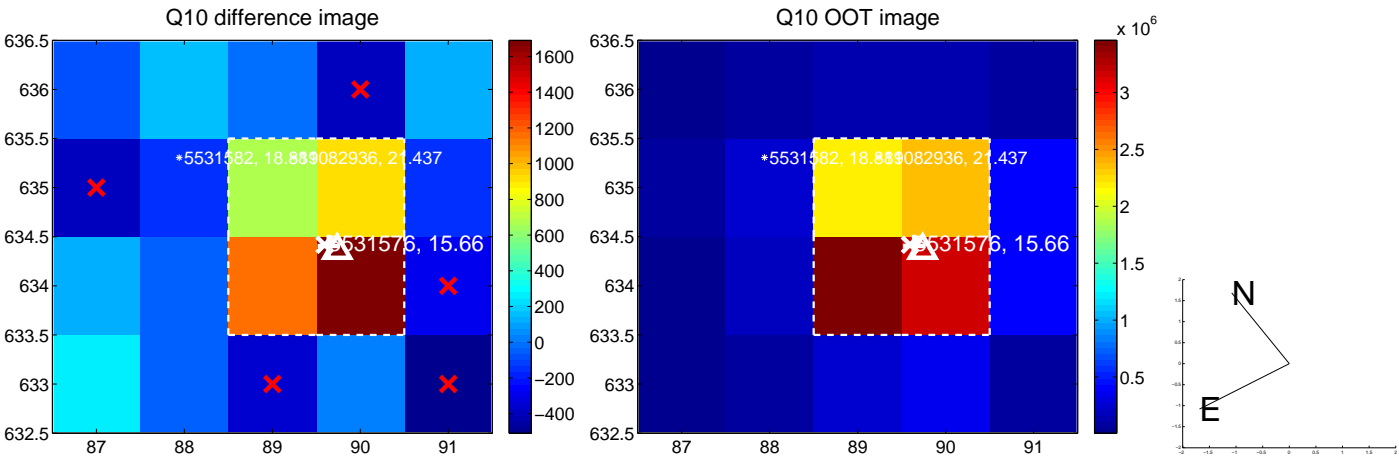
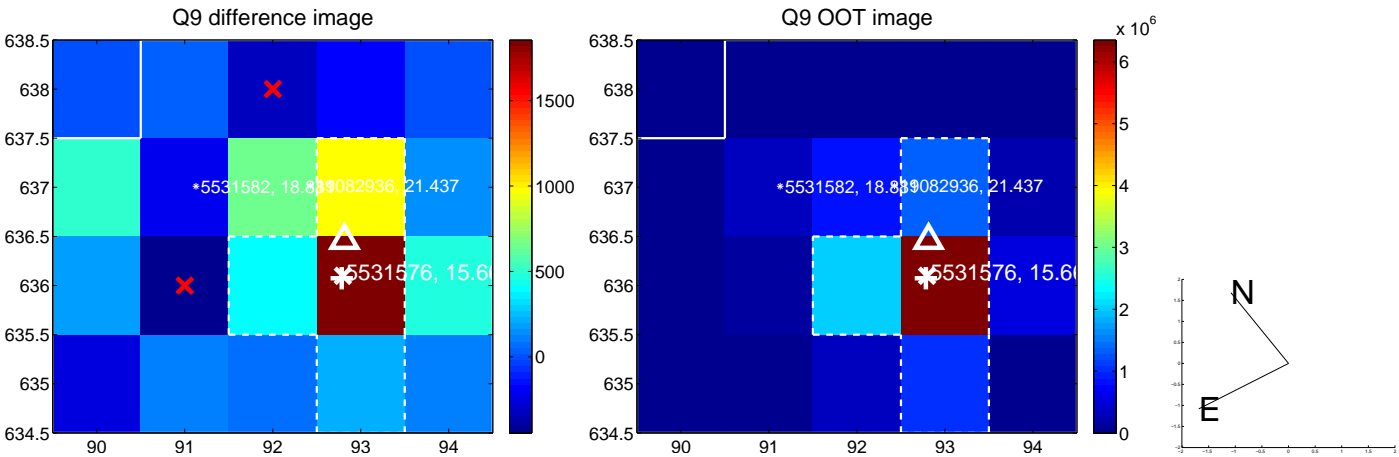
white \times : KIC target position; +: OOT centroid; \triangle : difference centroid. red \times : large negative pixel value.



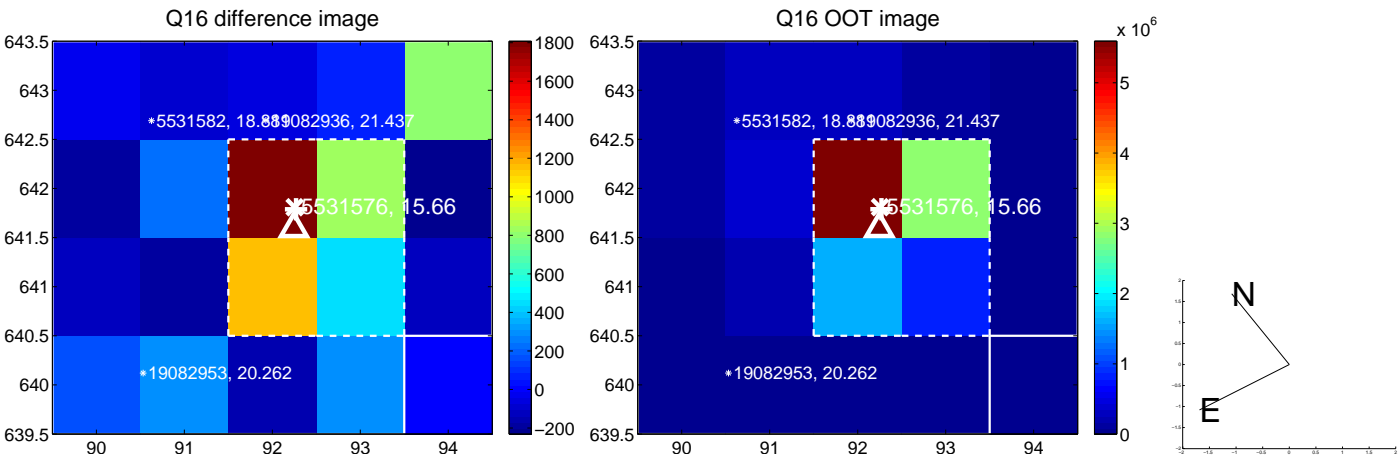
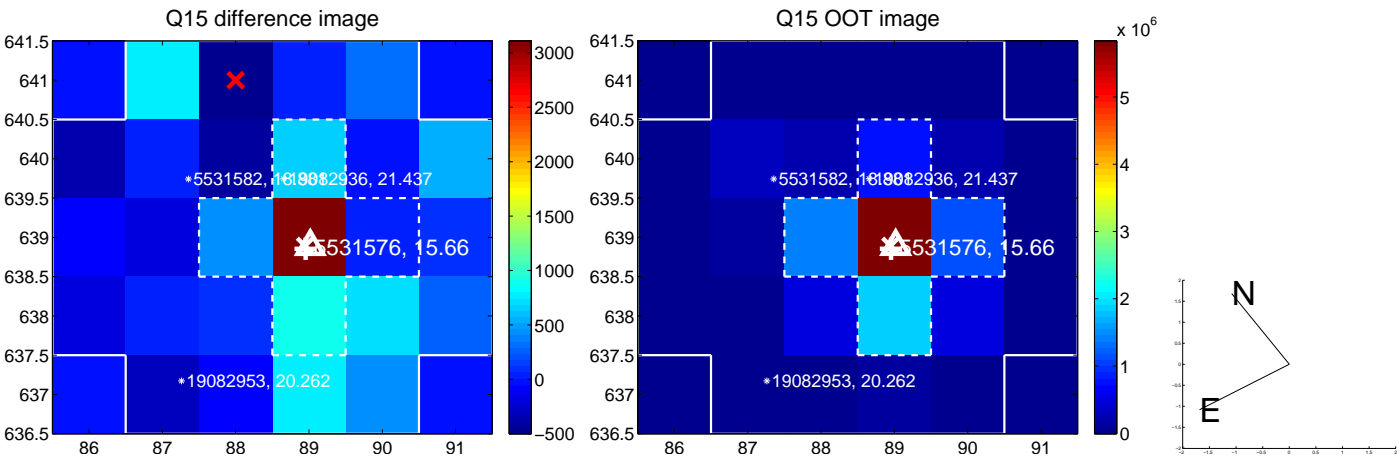
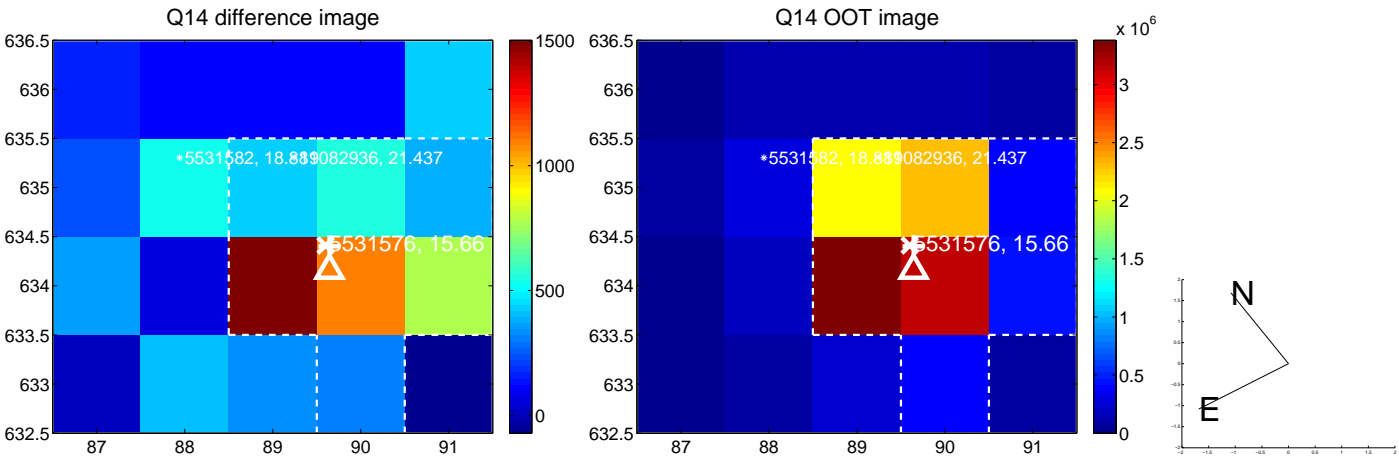
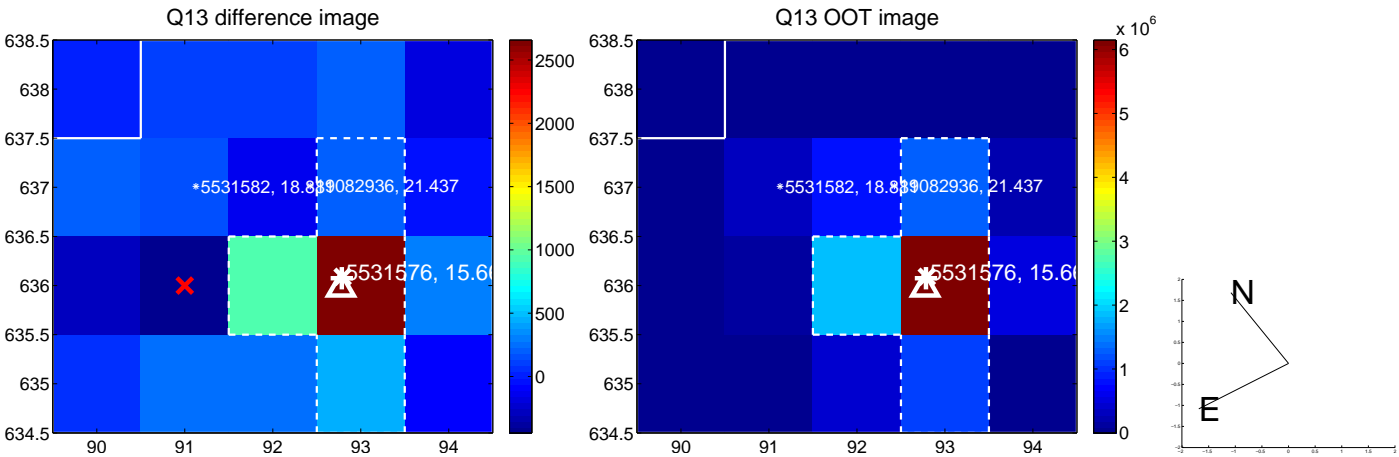
white \times : KIC target position; +: OOT centroid; \triangle : difference centroid. red \times : large negative pixel value.



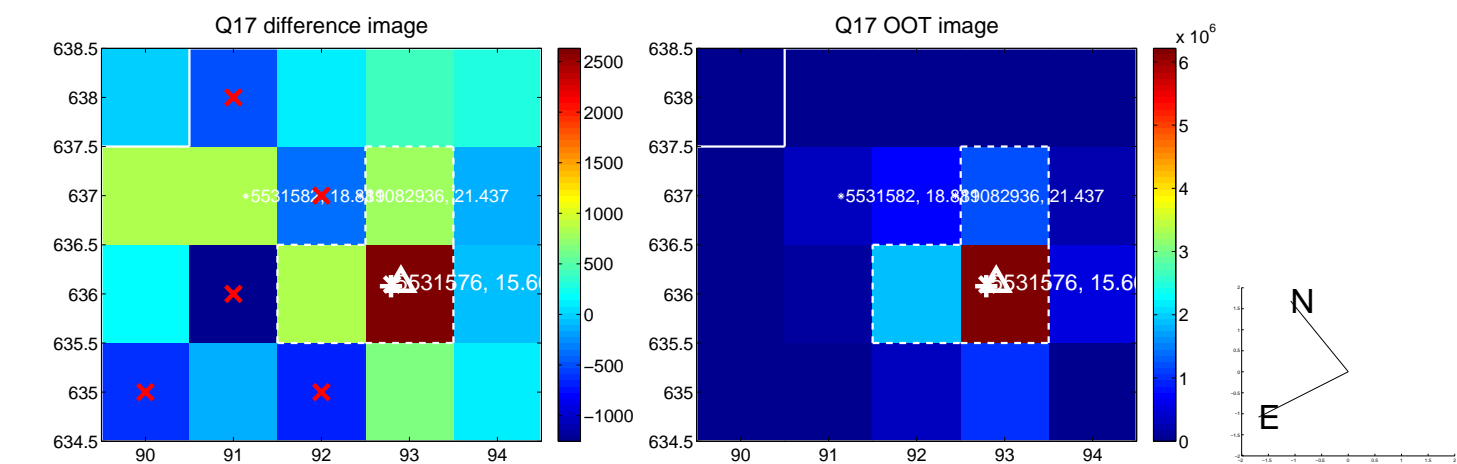
white \times : KIC target position; +: OOT centroid; \triangle : difference centroid. red \times : large negative pixel value.



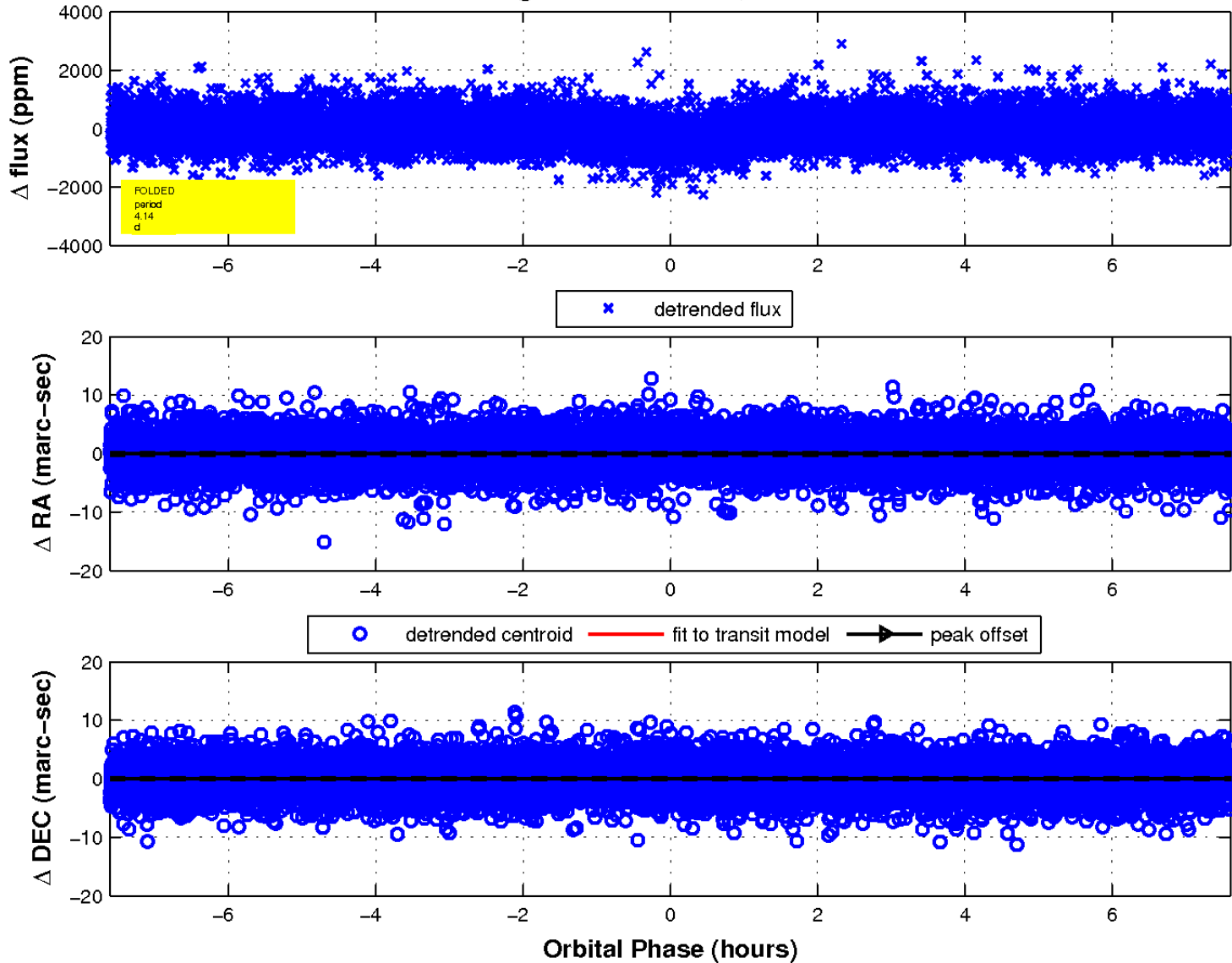
white \times : KIC target position; +: OOT centroid; \triangle : difference centroid. red \times : large negative pixel value.



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



fluxWeightedCentroids, Planet 2 of 2



UKIRT Image

Declination

