

A 7.77-day super-Earth candidate transiting the nearby M dwarf TIC 65043946, found in archival TESS full-frame images

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Abstract. We report a periodic transit-like signal on TIC 65043946 (2MASS J07102446–2439324), an early-M dwarf at 44.0 pc (144 light-years). The signal has period 7.77349 d, depth 1570 ± 145 ppm and duration 1.69 ± 0.14 h, and is seen in all five TESS sectors that observed the star (2019–2025), in three independent light-curve products. It is not a TOI or CTOI and no SPOC TCE exists for this star. Odd and even transits agree, there is no secondary eclipse, the depth is the same in every sector and in raw and corrected flux, the duration fits a transit across this dense star, the brightest neighbour shows no signal, and the Sector 88 difference image centres the dimming on the target pixel. TRICERATOPS gives $FPP = 0.077 \pm 0.000$, $NFPP = 0.0024 \pm 0.0004$ (2 runs). If the signal is on the target it is a $1.8 \pm 0.1 R_{\oplus}$ planet with insolation $\approx 7 S_{\oplus}$ and $T_{eq} \approx 454$ K. We claim a planet *candidate*, not a validated planet. TESS observes the star again in Sector 111; we publish the three predicted transit times and fixed decision rules before those data exist.

1. Why this star was missed

TESS searches its 2-minute targets with the SPOC pipeline, which stitches every sector together. Most stars, however, are recorded only in full-frame images (FFIs). TIC 65043946 had 2-minute data in a single sector (7, in 2019); its later observations (Sectors 33, 34, 87, 88) exist only as FFI light curves from the TESS-SPOC and QLP pipelines, so no multi-year search ever combined them. A single sector holds two to four shallow transits, too few to cross a detection threshold. Combining all five sectors gives fourteen.

2. Search

We searched nearby (< 60 pc) K and M dwarfs from the TESS Input Catalog with 2–45 sectors of data, using for each sector the best available product (SPOC 2-min, else TESS-SPOC FFI, else QLP FFI). Each sector was detrended with a 0.6 d biweight filter, data within 0.5 d of gaps were dropped, and periods of 0.6–25 d were searched in two stages: a box least-squares spectrum per observing season summed across seasons, then a coherent search over all data around each peak. Known TOI/CTOI signals were masked. Every signal passed through sixteen automatic checks (red-noise S/N, number of transits, single-event dominance, odd–even depth, secondary eclipse, duration versus stellar density, depth per sector, baseline flatness, period collisions with nearby stars, known TOI periods and others). The pipeline recovers both signals of TIC 4206066 (Rabotsevich 2026) and the confirmed Earth-sized planet TOI-6276.01 (HD 101581) without being told about them.

3. The signal

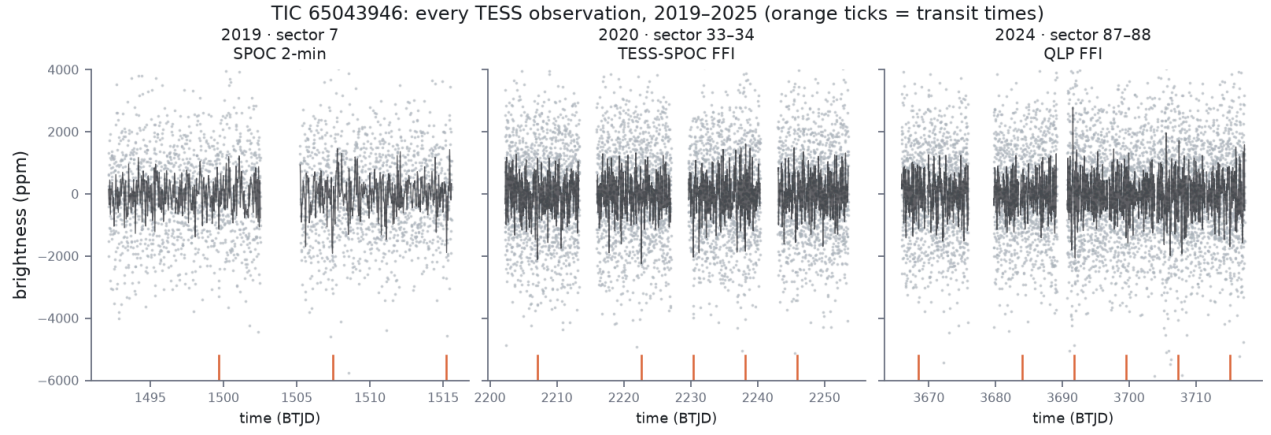


Figure 1. Every TESS observation of TIC 65043946. Orange ticks: transit times from the ephemeris below.

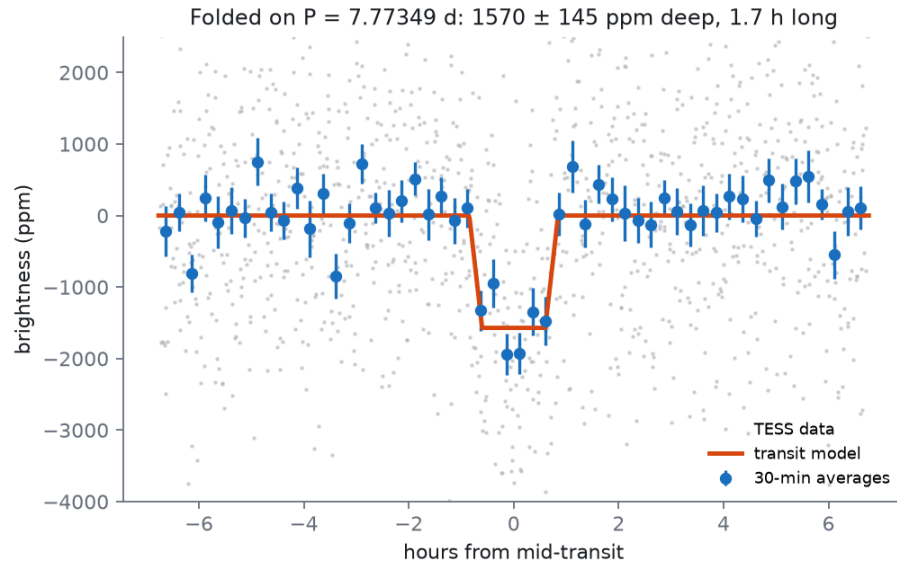


Figure 2. All fourteen transits folded on the best period, with the trapezoid model.

Parameter	Value
Period	7.7734904 ± 0.0000126 d
Mid-transit epoch	$\text{BJD}_{\text{TDB}} 2459245.93924 \pm 0.00162$
Depth	1570 ± 145 ppm (S/N 10.8)
Duration (T14)	1.69 ± 0.14 h (central transit would last 2.10 h; implied $b \approx 0.6$)
Transits / sectors	14 / 5 (2019–2025)
Star (TIC 8.2)	$T_{\text{eff}} 3486 \pm 157$ K, $R 0.417 \pm 0.012 R_{\odot}$, $M 0.411 M_{\odot}$, $d 44.05$ pc, $T_{\text{mag}} 11.69$, $J 10.24$
If on target	$R_p = 1.8 \pm 0.1 R_{\oplus}$, $a = 0.0571$ AU ($a/R_{\star} = 29$), $S \approx 7.1 S_{\oplus}$, $T_{\text{eq}} \approx 454$ K (zero albedo), $\text{RV } K \approx 2.9$ m/s for $5 M_{\oplus}$

4. Vetting

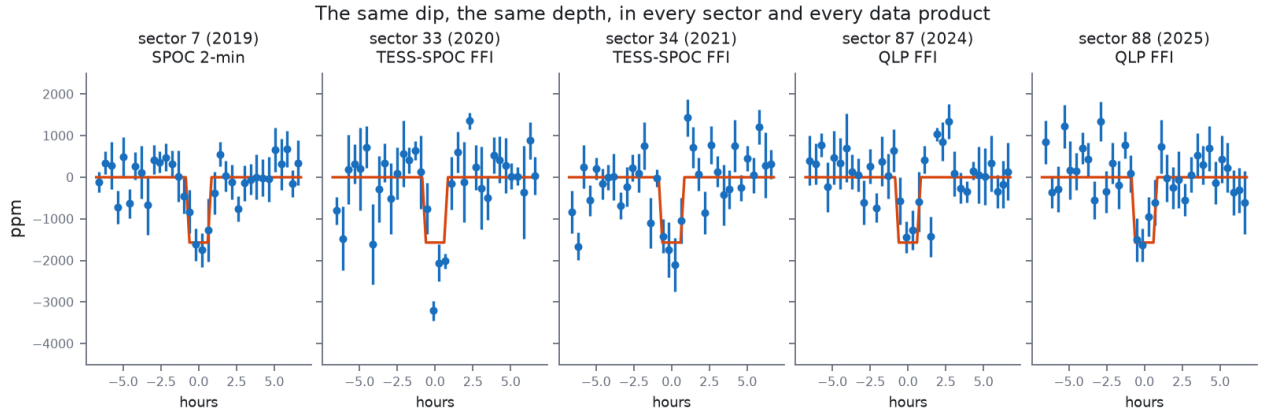


Figure 3. The transit in each sector separately. The model is the same in every panel.

Sector (year)	Product	Camera	Depth, corrected flux (ppm)	Depth, raw flux (ppm)
7 (2019)	SPOC 2-min	2	1519 ± 286	1381 ± 243
33 (2020)	TESS-SPOC FFI	2	2582 ± 426	1682 ± 292
34 (2021)	TESS-SPOC FFI	2	1613 ± 261	1264 ± 233
87 (2024)	QLP FFI	2	1383 ± 340	1428 ± 334
88 (2025)	QLP FFI	2	1521 ± 296	1355 ± 304

Depths with a 1.0 d detrending window. A blended neighbour's share of the aperture changes with every sector's camera and mask; a planet's depth does not. All five sectors and both flux types agree within their errors. The depth is also independent of the detrending window between 0.4 and 2.5 d.

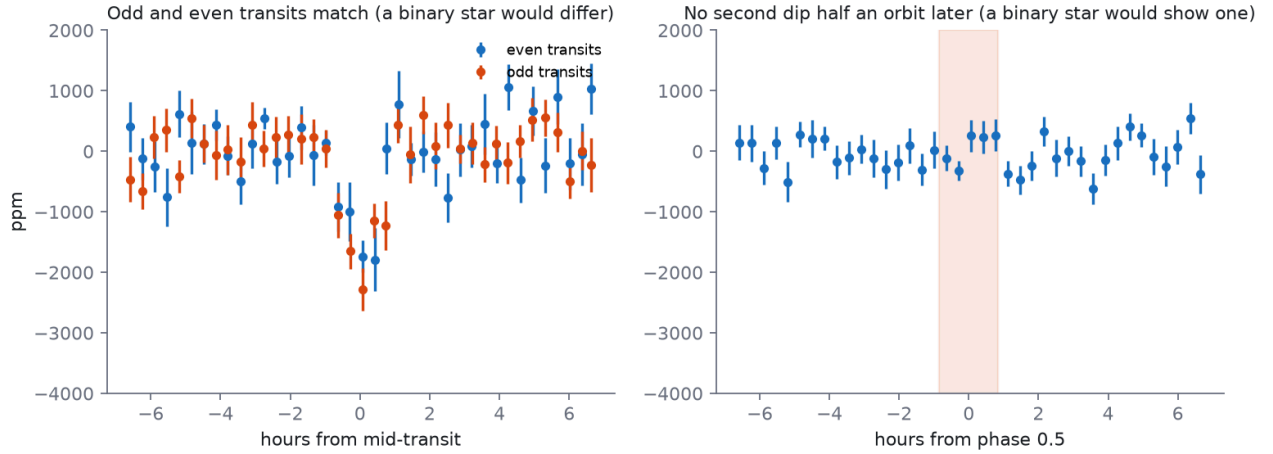


Figure 4. Left: odd and even transits. Right: the light curve half an orbit after transit, where an eclipsing binary would show its secondary eclipse.

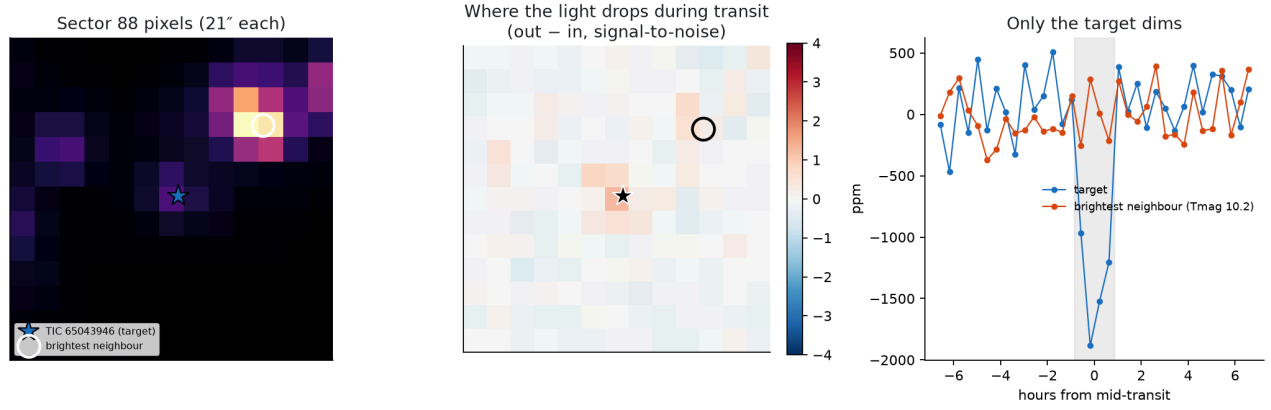


Figure 5. Is the target the star that dims? Left: Sector 88 pixels. Middle: out-of-transit minus in-transit image in units of its noise; the dimming falls on the target pixel. Right: the brightest neighbour (TIC 65043927, Tmag 10.2, 87'') folded on the same ephemeris shows -53 ± 102 ppm; to produce the target's signal it would need several thousand ppm.

Difference images in Sectors 7, 33, 34 and 87 are too noisy, or dominated by pointing-jitter residuals of the bright neighbour, to localise the dimming. Two faint neighbours (Tmag 13.5 at 32'' and 15.5 at 20'') have no light curves and could in principle host an eclipsing binary of 2.5 % or 8 % depth. TRICERATOPS (Giacalone & Dressing 2020), using the Sector 7 SPOC aperture, 644 Gaia DR3 stars within 10 pixels and a Gaia DR3 field population, gives **FPP = 0.077 ± 0.000**, **NFPP = 0.0024 ± 0.0004 (2 runs)**. This is below the "likely planet" bound (FPP < 0.5) but above the validation threshold (FPP < 0.015 and NFPP < 0.001; Giacalone et al. 2021).

5. Predictions for TESS Sector 111 (written before the data exist)

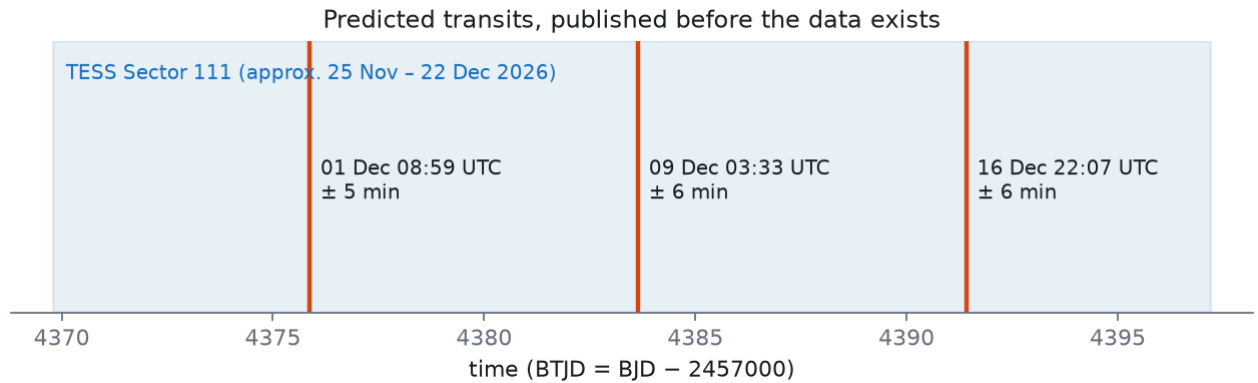


Figure 6. Predicted transits in Sector 111.

Predicted mid-transit (UTC)	BJD _{TDB}	1σ
2026-12-01 08:59 UTC	2461375.8756	± 5 min
2026-12-09 03:33 UTC	2461383.6491	± 6 min
2026-12-16 22:07 UTC	2461391.4226	± 6 min

Expected depth error for the three transits combined ≈ 313 ppm. **Supported** if the Sector 111 depth is above 3σ and within 2σ of 1570 ppm with no secondary; **refuted** if it is below 537 ppm, if a secondary appears, or if the centroid excludes the target; **inconclusive** otherwise. The rules, code and data are frozen with SHA-256 checksums in the accompanying archive.

6. Limitations

This candidate was selected as the best of many signals from thousands of stars, so a noise origin cannot be excluded by its S/N alone; the per-sector consistency argues against it but new data are the real test. There is no ground-based photometry, high-resolution imaging or spectroscopy. The stellar parameters are TIC values. FPP is not a validation.

Acknowledgements and AI disclosure

This paper uses data from the TESS mission (NASA Explorer Program) obtained from MAST, light curves from the SPOC, TESS-SPOC and QLP pipelines, the TESS Input Catalog, Gaia DR3 and ExoFOP-TESS. The search, vetting and this text were produced with Claude Code (Anthropic) working under the author's direction; the author is responsible for the content.

References. Ricker et al. 2015, JATIS 1, 014003 · Stassun et al. 2019, AJ 158, 138 · Caldwell et al. 2020, RNAAS 4, 201 · Huang et al. 2020, RNAAS 4, 204 · Hippke et al. 2019, AJ 158, 143 (wotan) · Kovács et al. 2002, A&A 391, 369 (BLS) · Giacalone & Dressing 2020, ascl:2002.004 · Giacalone et al. 2021, AJ 161, 24 · Rabtsevich 2026, Zenodo 10.5281/zenodo.22967456.