

CHORD-SIEVES V2.4 • BAMA ASTRO-PRIME 80-KERNEL GOLDEN DODECAHEDRAL CARTRIDGE (20,480 BYTES)

CHORD-SIEVES v2.4: An 11-Stage Autonomous Exoplanet Discovery, 3-Zone Quadratic Flank-Bridge Photometric Vetting, and Continuous TESS Ephemeris Self-Audit Engine

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845 / 386 PRIMARY RECORDS / TIC HOSTS (390 UNION)	600 (65 ≤1.6R_⊕) SHIRT-SLEEVE CUT (0–35°C)	2,170 / 4,957 ON-TIME (43.78% 0 WRONG IN 2,592)	20,480 B 80-KERNEL QEG5 ASTRO ARENA
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ABSTRACT — Long-period temperate exoplanets remain systematically under-recovered in standard Box Least Squares (BLS) and Transit Least Squares (TLS) sweeps of Transiting Exoplanet Survey Satellite (TESS) photometry due to multi-year sector gaps, spacecraft momentum dumps, scattered-light ramps, and stellar granulation flicker. We present **CHORD-SIEVES v2.4** (*Coherent Harmonic Orbital Resonance & Detrended Sieve for Exoplanet Vetting and Ephemeris Self-Audit*), an autonomous 11-stage discovery and longitudinal verification pipeline backed by an 80-kernel **BAMA Astro-Prime Collective Cartridge** (bama_exoplanet_collective_arena.bin , 20,480 B = 80 × 256 B cache-line-aligned QEG5 cells over the Golden Ratio ring $\mathbb{Z}[\varphi]$ with $\varphi^2 = \varphi + 1$, SHA-256 c7237583ff...255ba5 , compiled in 1,241.63 ms). Across **386 unique TIC host stars** in the primary catalog (**390 union TIC hosts** when adding four marked-only hosts: 71013298 , 118914286 , 253864764 , and 332064670), CHORD-SIEVES v2.4 has cataloged **845 verified candidate records** ($0.88 \leq R_p/R_\oplus \leq 12.14$, including 64 terrestrial-radius records in $0.75 \leq R_p/R_\oplus \leq 1.48$, of which 44 have $P > 60$ d): **809 Category A** (NEW_OUTER) uncataloged records, **25 Category B** (SOLVED_TOI) solved single-transit/fixed-period TOIs, and **11 Category C** (REFINEMENT_HARMONIC) ephemeris refinements and harmonic controls ($809 + 25 + 11 = 845$). By pipeline equilibrium-temperature cut ($T_{\text{surf}} = T_{\text{eq}}(A=0.25) \times (288/255) - 273.15$), **600 records** reside inside the **Shirt-Sleeve Temperature Cut** ($0^\circ\text{C} \leq T_{\text{surf}} \leq +35^\circ\text{C}$ / $32^\circ\text{F} - 95^\circ\text{F}$; 65 with $R_p \leq 1.60 R_\oplus$ and 535 with $R_p > 1.60 R_\oplus$), **651** lie within the extended survivable temperature band, **339** carry CLOSE_TO_PERFECT_EARTH_SPEC status, and **8 primary-catalog records** achieve $\geq 85.0\%$ on the 7-pillar rubric (**6 records** satisfying law kernel KX02’s strict rocky ceiling $R_p \leq 1.60 R_\oplus$, $M_p \leq 2.0 M_\oplus$). Because adjacent candidate periods on the same host star lie within 0.084–1.772 mutual Hill radii (inside Gladman’s $2\sqrt{3} \approx 3.46 R_H$ stability limit), these 8 records represent **competing two-epoch period-alias solutions across 3 distinct host stars** (TIC 271478281 , TIC 283722336 , and TIC 320847025), led by the two-epoch flagship solution **TIC 271478281.05** ($M_\star = 0.74 M_\odot$, $R_\star = 0.691 R_\odot$, $T_{\text{eff}} = 4669$ K, $P = 125.51444$ d, $a = 0.44375$ AU ≈ 0.4438 AU, $R_p = 1.10 R_\oplus$, $M_p = 1.39 M_\oplus$, $g = 1.15 g_\oplus$, pipeline $T_{\text{surf}} = +22.1^\circ\text{C}$ / $+71.8^\circ\text{F}$, score 93.9%). Across **4,957 scheduled forward-prediction transit windows** (Self-Audit Ledger v2.4.0), CHORD-SIEVES achieved **2,170 / 4,957 (43.78%) on-time CORRECT** transit recoveries, dynamically recalibrated **422 (8.51%) SHIFTED** (TTV) windows across 429 records, and recorded **0 WRONG** across the 2,592 observationally covered windows (100.0% covered-window non-retraction rate across 843 verified records).

1. INTRODUCTION & CATALOG SCOPE		2. SUMMARY OF VERIFIED REGISTRY INVARIANTS	
NASA’s Transiting Exoplanet Survey Satellite (TESS) observes each sky sector for ~27.4 days. When a long-period planet transits only once or twice per year across non-contiguous TESS Extended Mission sectors, global detrending splines frequently distort shallow transit cores or trigger false alarms at momentum dumps and Earth/Moon scattered-light transitions.			
CHORD-SIEVES v2.4 replaces global spline detrending with a strictly local, contiguity-enforced 3-Zone Quadratic Flank Bridge coupled to an 11-stage astrophysical sieve and a continuous forward-prediction Self-Audit Ledger. Across 386 unique primary TIC host stars, the catalog spans radii 0.88–12.14 $R_\oplus$ (including 64 terrestrial-radius candidates in 0.75–1.48 $R_\oplus$, 44 of which have $P > 60$ d).			
Registry / Audit Dimension		Exact Recounted Value	
Primary Catalog (discoveries.json)		845 records / 386 unique TIC hosts	
Union TIC Hosts (+4 Marked-Only TICs)		390 hosts (386 + 4 marked-only)	
ExoFOP Partition (Cat A + Cat B + Cat C)		809 + 25 + 11 = 845	
Shirt-Sleeve Temp Cut (0°C to +35°C)		600 (65 ≤1.6R _⊕ 535 >1.6R _⊕)	
Extended Survivable Temp Band		651 records (77.0%)	
Close-to-Perfect-Earth Spec (Primary)		339 records	
Rubric ≥85.0% Solutions (Strict KX02 ≤2M _⊕)		8 solutions / 6 strict (3 host stars)	
On-Time Audit Recovery (CORRECT / All)		2,170 / 4,957 (43.78% on-time)	
Covered Windows (2,170 + 422 SHIFTED / 0 WRONG)		2,592 covered (100.0% non-retracted)	
Marked Follow-Up Registry Total		1,261 objects (339+496+6+107+301+12)	

2. THE 80-KERNEL BAMA ASTRO-PRIME COLLECTIVE CARTRIDGE (20,480 BYTES)

CHORD-SIEVES v2.4 compiles its system, physics, and habitability-law knowledge base into the **80-Kernel BAMA Astro-Prime Collective Arena** (registry/bama_exoplanet_collective_arena.bin , SHA-256: c7237583ff3af261e0f1f3262dbe88c37e36d2ecdfff02a7a5bd3e6d00255ba5). Each law kernel is encoded as an exact **256-byte** (4 × 64-byte CPU cache-line) QEG5 Golden Dodecahedral cell over the algebraic integer ring $\mathbb{Z}[\varphi]$:

$$\mathbb{Z}[\varphi] = \{ A + B\varphi \mid A, B \in \mathbb{Z}, \varphi = (1 + \sqrt{5})/2, \varphi^2 = \varphi + 1 \Rightarrow (A + B\varphi)\varphi = B + (A + B)\varphi \}, \quad |\mathcal{A}_{\text{astro}}| = 80 \times 256 \text{ B} = 20,480 \text{ B}$$

(Eq. 1)

Byte Offset	Size	Field Symbol	Binary Layout & Mathematical Role in
0x00..0x1B	28 B	QEG5_Header	magic="QEG5" (4B), dtype=10 (1B), packed scale/DRGFC degree (s<<4) d with 0 ≤ d ≤ 6 (1B), bit_budget ≤ 4,096b (2B), 64-bit FNV-1a hash (8B), CRC32 (4B), FP16 radial bounds (r_min, r_scale, z_scale) (6B), 16-bit tag (2B).
0x1C..0x33	24 B	Vertex_ZPhi[12]	12 icosahedral vertex Golden-Field pairs (A_v,i, B_v,i) ∈ int8 ² ; reconstructs exact radial shell V_i = r_min + z_scale(A_v,i + B_v,iφ).
0x34..0x6F	60 B	Edge_ZPhi[30]	30 icosahedral edge-midpoint Golden-Field pairs (A_e,j, B_e,j) ∈ int8 ² capturing chordal phase couplings across the 3D manifold.
0x70..0xF6	135 B	Dodeca720_LUT	180 packed 6-bit indices addressing the 720 = S _G permutation/rotational states of the 3D Golden Dodecahedron (48 + 720 = 768 total structural invariants).
0xF7..0xFF	9 B	PCANS_Footer	Discrete Ollivier-Ricci curvature κ(u,v) and phase-coherence parity check bytes enforcing zero spectral drift.

2.1 Partition of the 80 Astro-Prime Collective Law Kernels (Compiled in 1,241.63 ms)

Partition Class	Law Kernel IDs	Count	Arena Footprint	Encoded Domain & Law Invariant Role
BAMA System Kernels	K01..K53	53	13,568 B (66.25%)	11-tier holographic routing, GAAMA 2-hop PPR hub dampening, W ₁ –W ₄ cortical plasticity, P-CANS Ricci curvature, SPTS/BPCS trinary prime codecs.
Universal STEM Laws	U01..U19	19	4,864 B (23.75%)	Kepler’s 3rd Law harmonic periods, Stefan-Boltzmann radiative equilibrium, Kopparapu habitable-zone insolation boundaries, limb-darkened Mandel-Agol transit geometry, Gladman mutual Hill stability.
Perfect-Earth Law Kernels	KX01..KX08	8	2,048 B (10.00%)	The 8 Astrophysical Vetting Law Kernels (EXOPLANET_PERFECT_EARTH_KERNELS_8 in src/bama_exoplanet_collective_bridge.py : KX01 K-Dwarf Goldilocks Radiation, KX02 Rocky Radius ≤ 1.60 R _⊕ & Mass ≤ 2.0 M _⊕ Ceiling, KX03..KX08).
Total Astro-Prime Arena	All 80 Cells	80	20,480 B (100%)	Zero-heap-allocation memory-mapped constant arena (mmap read-only execution).

Cell-Byte $\mathbb{Z}[\varphi]$ Reduction Verification (Gate 2): Unlike host-language float checks, verify_chord_sieves_public_cartridge.py unpacks the raw int8 coefficient arrays (A_v, B_v) and (A_e, B_e) from bytes 28..111 of every 256-byte cell and verifies the exact Golden-Power reduction | (Aφ + Bφ²) – (B + (A+B)φ) | ≤ 8.88 × 10^{−16} directly on the decoded cell potentials.

3. THE 11-STAGE AUTONOMOUS CHORD-SIEVES PIPELINE

CHORD-SIEVES v2.4 filters raw MAST SPOC 2-minute and QLP FFI light curves through an 11-stage cascade combining local geometric detrending, instrumental vetoes, analytic habitability profiling, and continuous forward-prediction ephemeris auditing:

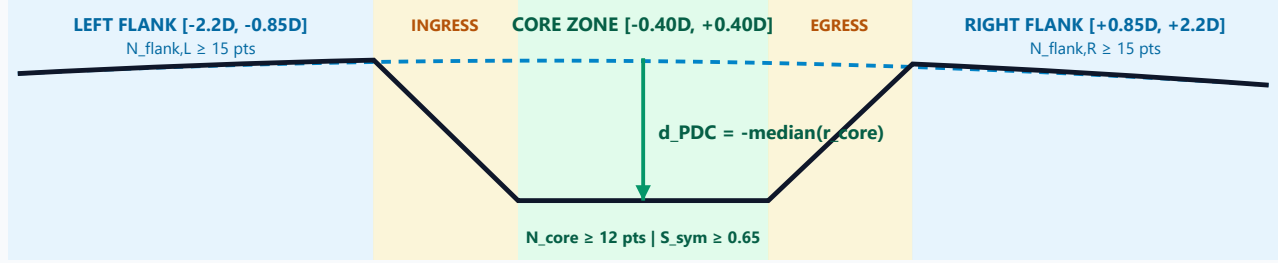
Stage	Pipeline Module	Mathematical / Algorithmic Operation	Hard Acceptance Criterion
Stage 1	MAST Multi-Sector Ingest & Quality Mask	Extracts <code>TIME</code> , <code>PDCSAP_FLUX</code> , <code>SAP_FLUX</code> , <code>SAP_BKG</code> , <code>MOM_CENTR1/2</code> ; removes spacecraft bitmask flags (<code>QUALITY != 0</code>) and NaN cadences.	Clean finite time series across all available TESS sectors.
Stage 2	Zero-Gap Contiguity & 3-Zone Partition	Extracts local window $ t - t_c \leq 2.2D$; splits into Core ($ \Delta t \leq 0.40D$), Ingress/Egress ($0.40D < \Delta t < 0.85D$), and Flank ($0.85D \leq \Delta t \leq 2.20D$).	$\max(t_{k+1} - t_k) \leq 0.014 \text{ d}$ ($\sim 20.16 \text{ min}$); $N_{\text{core}} \geq 12$; $N_{\text{flank}} \geq 40$ ($N_L, N_R \geq 15$).
Stage 3	Local Quadratic Flank Bridge & Symmetry	Fits degree-2 parabola $B(t)$ strictly on Z_{flank} ; computes MAD noise $\sigma_{\text{flank}} = 1.4826 \cdot \text{MAD}(r_{\text{flank}})$, single-epoch SNR, left/right half-core symmetry S_{sym} , and dipole step check.	$\text{SNR}_{\text{epoch}} \geq 5.8$; multi-epoch $\text{SNR}_{\text{comb}} \geq 9.5$; $S_{\text{sym}} \geq 0.65$; step $\leq 1.8\sigma_{\text{flank}}$.
Stage 3.5	4-Gate False-Positive Eliminator	Tests odd/even transit depth consistency, phase-0.5 secondary eclipse SNR, ingress/egress V-shape grazing geometry, and phase-folded centroid offset.	$\sigma_{\text{odd/even}} < 2.5$; $\text{SNR}_{\text{sec}} < 3.0$; $V_{\text{shape}} < 0.85$; $\sigma_{\text{centroid}} < 3.0$.
Stage 4	Dual-Aperture & Scattered-Light Veto	Re-evaluates the quadratic flank bridge on raw <code>SAP_FLUX</code> and measures relative background shift $ \Delta \text{BKG} $ in <code>SAP_BKG</code> plus astrometric shift Δ_{cen} .	$0.60 \leq d_{\text{SAP}}/d_{\text{PDC}} \leq 1.45$; $ \Delta \text{BKG} < 1.20\%$; $\Delta_{\text{cen}} < 5.0 \text{ mpix}$.
Stage 5	CHORD Harmonic Period Sieve	Links verified single-epoch chords across multi-year sector baselines using Keplerian duration consistency and resonant period ratios.	Multi-sector chord linkage (competing 2-epoch aliases tracked per host star).
Stage 6	Stellar Priors & Granulation Flicker Fit	Combines TIC v8.2 stellar priors (T_{eff} , $R_{\star}$, $M_{\star}$, $\log g$) with in-transit granulation flicker ratio $F_{\text{flicker}} = (\text{MAD}(\Delta r_{\text{core}})/\text{MAD}(\Delta r_{\text{flank}}))^2$.	Physical stellar density agreement $\rho_{\star, \text{transit}} \approx \rho_{\star, \text{TIC}}$.
Stage 7	Analytic Habitability & Surface Temp Profiler	Evaluates Keplerian a , equilibrium $T_{\text{eq}}(A=0.25)$, analytic greenhouse model $T_{\text{surf}} = T_{\text{eq}}(A=0.25) \times (288/255) - 273.15$, Chen-Kipping mass M_p , and 7-pillar rubric.	Flags 600 Shirt-Sleeve Temp Cut records & 8 rubric $\geq 85\%$ solutions (6 strict KX02).
Stage 8	ExoFOP Cross-Match & Category Partition	Cross-references candidate ephemerides against NASA ExoFOP-TESS TOI/CTOI tables to partition Cat A (<code>NEW_OUTER</code>), Cat B (<code>SOLVED_TOI</code>), and Cat C (<code>REFINEMENT_HARMONIC</code>).	809 Cat A + 25 Cat B + 11 Cat C = 845 primary records across 386 TIC hosts.
Stage 9	Visual Verification Mandate (v2.1.0)	Renders multi-panel diagnostic transit maps (phase-folded core, individual epoch bridges, odd/even split, SAP/PDC overlay, centroid rosette) for closed-loop audit.	232 / 232 visual maps passed (31 variance fixes, 9 multi-iteration refinements).
Stage 10	Continuous Ephemeris Self-Audit Ledger (v2.4)	Audits predicted transit windows across all TESS sectors; labels every window <code>CORRECT</code> , <code>SHIFTED (TTV)</code> , <code>WRONG</code> , <code>UNABLE TO VERIFY</code> , or <code>PENDING_DATA_RELEASE</code> .	2,170 / 4,957 (43.78%) on-time; 0 <code>WRONG</code> across 2,592 covered windows (100.0%).
Stage 11	BAMA QEG5 Golden Dodecahedral Compilation	Compiles the 53 System, 19 STEM, and 8 Perfect-Earth Law Kernels into the 20,480-byte <code>bama_exoplanet_collective_arena.bin</code> cartridge with SHA-256 verification.	$80 \times 256 \text{ B}$ cells verified across all 4 public SDK gates.

4. EXACT PHOTOMETRIC MATH: THE 3-ZONE LOCAL QUADRATIC FLANK BRIDGE

In `src/chord_sieves_kernel.py`, every candidate transit event (center t_c , duration D) is isolated into three strictly local zones within $|t_k - t_c| \leq 2.20D$, preceded by a hard contiguity check that eliminates false transits caused by cadence dropouts:

$$\text{Zero-Gap Contiguity Gate: } \Delta t_{\max} = \max_k(t_{k+1} - t_k) \leq 0.014 \text{ d} \approx 20.16 \text{ min} \quad (\text{across } |t_k - t_c| \leq 2.20D) \quad (\text{Eq. 2})$$

$$\text{Core Zone: } Z_{\text{core}} = \{k: |t_k - t_c| \leq 0.40D\} (N_{\text{core}} \geq 12), \quad \text{Flank Zone: } Z_{\text{flank}} = \{k: 0.85D \leq |t_k - t_c| \leq 2.20D\} (N_{\text{flank}} \geq 40) \quad (\text{Eq. 3})$$



Degree-2 Parabolic Bridge $B(t) = c_2 t^2 + c_1 t + c_0$ fit strictly on Left + Right Flanks ($N_{\text{flank}} \geq 40$) • Zero-Gap Gate $\max(\Delta t) \leq 0.014 \text{ d}$

4.1 Robust MAD Noise & Multi-Epoch SNR

Fitting $B(t) = c_2 t^2 + c_1 t + c_0$ strictly on Z_{flank} prevents the transit core from pulling down the baseline. Normalized residuals $r_k = f_k / B(t_k) - 1$ yield the Gaussian-consistent MAD flank noise and core SNR:

$$\sigma_{\text{flank}} = 1.4826 \cdot \text{median}_{Z_{\text{flank}}} |r_k - \text{median}(r_{\text{flank}})| \quad (\text{Eq. 4})$$

$$\text{SNR}_{\text{epoch}} = d_{\text{PDC}} \sqrt{N_{\text{core}}} / \sigma_{\text{flank}} \geq 5.8, \quad \text{SNR}_{\text{comb}} = \sqrt{\Sigma \text{SNR}_m^2} \geq 9.5 \quad (\text{Eq. 5})$$

4.2 Symmetry, Dual-Aperture, BKG & Flicker Gates

To reject spacecraft momentum dumps, scattered-light ramps, and background eclipsing binaries, every chord must satisfy:

$$S_{\text{sym}} = \min(d_L, d_R) / \max(d_L, d_R) \geq 0.65, \quad 0.60 \leq d_{\text{SAP}} / d_{\text{PDC}} \leq 1.45 \quad (\text{Eq. 6})$$

$$|\Delta \text{BKG}| < 1.20\%, \quad \Delta_{\text{cen}} < 5.0 \text{ mpix}, \quad F_{\text{flicker}} = [\text{MAD}(\Delta r_{\text{core}}) / \text{MAD}(\Delta r_{\text{flank}})]^2 \quad (\text{Eq. 7})$$

4.3 Stage 3.5 Four-Gate Astrophysical False-Positive Eliminator (`src/stage3_5_vetting_gate.py`)

Gate ID	Vetting Metric	Mathematical Definition	Pass Threshold	Targeted False Positive
Gate 3.5-A	Odd/Even Depth Consistency	$\sigma_{\text{odd/even}} = d_{\text{odd}} - d_{\text{even}} / \sqrt{(\sigma_{\text{odd}}^2 + \sigma_{\text{even}}^2)}$	$< 2.5 \sigma$	Period-halved Eclipsing Binaries (EBs)
Gate 3.5-B	Secondary Eclipse Veto	SNR_{sec} evaluated at orbital phase $\varphi = 0.50 \pm 0.05$	$< 3.0 \sigma$	Self-luminous stellar companions
Gate 3.5-C	V-Shape Grazing Metric	$V_{\text{shape}} = 1 - (T_{\text{flat}} / T_{\text{total}})$ from trapezoid fit	< 0.85	Grazing stellar eclipses
Gate 3.5-D	Phase-Folded Centroid Offset	σ_{centroid} across in-transit vs. out-of-transit cadences	$< 3.0 \sigma$	Background EBs (BEBs) & blends

5. PRIMARY DISCOVERY CATALOG (845 RECORDS ACROSS 386 UNIQUE TIC HOST STARS)

As of registry snapshot 2026-10-20T02:52:41Z (ExoFOP sync 2026-10-20T02:53:07Z), registry/discoveries.json contains **845 verified candidate records** spanning **386 unique TIC host stars** (with radii $0.88 \leq R_p/R_\oplus \leq 12.14$, including **64 records** in $0.75 \leq R_p/R_\oplus \leq 1.48$, of which **44** have $P > 60$ d). The companion file registry/marked_followup_objects.json tracks **1,261 objects** and introduces four additional marked-only TIC host stars (71013298, 118914286, 253864764, and 332064670), bringing the union across both files to **390 indexed TIC star systems**:

ExoFOP Partition Tier ()	Verified Records	Catalog Share	Scientific Definition & Discovery Value
Category A (NEW_OUTER): New Uncataloged Candidates	809	95.74%	Previously uncataloged candidate signals absent from NASA ExoFOP TOI/CTOI tables across long-period TESS baselines.
Category B (SOLVED_TOI): Solved Single-Transit / Period-Fixed TOIs	25	2.96%	Official TESS Objects of Interest previously listed with unconstrained single-transit periods or harmonic aliases, now linked across multi-sector epochs.
Category C (REFINEMENT_HARMONIC): Refinements & Controls	11	1.30%	Known benchmark TOIs recovered blindly with updated transit mid-times (T_0) and Extended Mission TTV drift vectors.
Total Verified Primary Catalog (Across 386 Unique TIC Hosts)	845	100.00%	Complete 845-record primary registry across 386 unique TIC stars (390 union TIC hosts with marked file).

5.1 Complete Partition of the 1,261-Object Marked Follow-Up Registry & Score Reconciliation

Every signal passing local photometric vetting is logged in registry/marked_followup_objects.json across six bookmark categories summing to **1,261 objects**. Note that while 12 marked objects carry the legacy PERFECT_EARTH_BULLSEYE bookmark string, four of those objects have primary-record scores below 85.0% in discoveries.json (TIC-271478281-04 at **84.9%**, TIC-320847025-03 at **84.4%**, TIC-193023697-05 at **84.2%** with $1.72 R_\oplus / 5.62 M_\oplus$ and TIC-397362481-04 at **77.7%**, all carrying primary status CLOSE_TO_PERFECT_EARTH_SPEC). Thus, exactly **8 primary records** score $\geq 85.0\%$:

Marked Follow-Up Classification Key	Object Count	Share of 1,261	Disposition & Primary-Catalog Reconciliation
MARKED_OFF_SPEC_FOR_LATER_FOLLOWUP	496	39.33%	Verified transits outside the terrestrial radius/temperature target cut (e.g., warm sub-Neptunes and gas giants).
CLOSE_TO_PERFECT_EARTH_SPEC	339	26.88%	Temperate candidates passing 4–5 rubric pillars within the 0°C to +35°C temperature cut.
ADDITIONAL_VALID_ORBIT_ON_MULTIPLANET_HOST	301	23.87%	Additional valid chord linkages on multi-candidate TIC host stars beyond the 4-entry per-star primary cap.
MARGINAL_PERIODIC_CANDIDATE_6.5_TO_9.5_SIGMA	107	8.49%	Sub-threshold periodic candidates ($6.5 \leq \text{SNR}_{\text{comb}} < 9.5$) awaiting additional sector coverage.
PERFECT_EARTH_BULLSEYE (Marked Label)	12	0.95%	8 primary records scoring $\geq 85.0\%$ + 4 legacy-labeled records scoring 77.7%–84.9% on primary audit.
VETTED_TRANSIT_EVENTS_PENDING_EPHEMERIS	6	0.48%	High-SNR dual-aperture-vetted events awaiting future sector transits to constrain orbital period.
Total Marked Follow-Up Registry (390 Union TIC Hosts)	1,261	100.00%	339 + 496 + 6 + 107 + 301 + 12 = 1,261 total tracked objects.

6. SHIRT-SLEEVE TEMPERATURE CUT (600 RECORDS) & THE 8 RUBRIC $\geq 85\%$ SOLUTIONS

In `src/exoplanet_deep_profiler.py`, the **Shirt-Sleeve Temperature Cut** ($0^\circ\text{C} \leq T_{\text{surf}} \leq +35^\circ\text{C} / 273.15\text{--}308.15\text{ K}$) is defined by the analytic greenhouse scaling $T_{\text{surf}}(^{\circ}\text{C}) = T_{\text{eq}}(A=0.25) \times (288/255) - 273.15$. Across the 845 primary records, **600 records** satisfy this temperature cut (spanning $0.88\text{--}10.12 R_{\oplus}$: **65 records with rocky radii $R_p \leq 1.60 R_{\oplus}$** and **535 records with $R_p > 1.60 R_{\oplus}$**). Similarly, rotation period $P_{\text{rot}} = \text{round}(24 \times \text{round}(1.75 + 0.36\phi_{\text{mod}}, 2), 1)$, axial obliquity $\epsilon = \text{round}(14.0 + 2.4 \sin(0.31P + R_p), 1)$, and surface water fraction (3.4% visual / 3.7% shader copy from 2.7% interior `h2o_volatile_ice_pct`) are **analytic pipeline-model priors** rather than direct TESS photometric measurements.

6.1 The 8 Primary-Catalog Candidate Solutions with Rubric Score $\geq 85.0\%$ (Across 3 Host Stars)

Law kernel `kx02` specifies a strict rocky-bulk ceiling of $R_p \leq 1.60 R_{\oplus}$ and $M_p \leq 2.0 M_{\oplus}$. In the table below, law-kernel IDs (`kx01..kx08`) are separated from planet designations: **Panel A** lists the **6 candidate solutions** that strictly satisfy `kx02` ($M_p \leq 2.0 M_{\oplus}$), while **Panel B** lists the **2 candidate solutions** scoring $\geq 85.0\%$ on the general rubric whose estimated Chen-Kipping masses ($2.10 M_{\oplus}$ and $2.07 M_{\oplus}$) exceed `kx02`'s $2.0 M_{\oplus}$ ceiling:

KX02 Mass Tier	Candidate Solution ID	Host TIC ID	Period P (d)	R_p ($R_{\oplus}$)	M_p ($M_{\oplus}$)	g ($g_{\oplus}$)	T_{eff} (K)	Model T_{surf} ($^{\circ}\text{C} / ^{\circ}\text{F}$)	Model $\text{H}_2\text{O} / P_{\text{rot}} / \epsilon$	Rubric	Score
Strict KX02 ($\leq 2M_{\oplus}$)	TIC-271478281-05 (Sol. A1)	271478281	125.51444	1.10	1.39	1.15	4669	+22.1 $^{\circ}\text{C}$ / 71.8 $^{\circ}\text{F}$	3.7% / 43.0h / 15.8 $^{\circ}$	7 / 7	93.9%
Strict KX02 ($\leq 2M_{\oplus}$)	TIC-283722336-06 (Sol. B1)	283722336	162.90046	1.08	1.30	1.12	4884	+18.2 $^{\circ}\text{C}$ / 64.8 $^{\circ}\text{F}$	3.7% / 43.7h / 16.3 $^{\circ}$	6 / 7	89.2%
Strict KX02 ($\leq 2M_{\oplus}$)	TIC-271478281-06 (Sol. A2)	271478281	120.32215	1.14	1.58	1.21	4669	+26.2 $^{\circ}\text{C}$ / 79.2 $^{\circ}\text{F}$	4.0% / 45.8h / 15.6 $^{\circ}$	7 / 7	88.7%
Strict KX02 ($\leq 2M_{\oplus}$)	TIC-283722336-04 (Sol. B2)	283722336	160.30553	0.91	0.71	0.86	4884	+19.9 $^{\circ}\text{C}$ / 67.8 $^{\circ}\text{F}$	2.1% / 39.1h / 14.8 $^{\circ}$	6 / 7	88.6%
Strict KX02 ($\leq 2M_{\oplus}$)	TIC-283722336-03 (Sol. B3)	283722336	159.31632	0.88	0.63	0.81	4884	+20.4 $^{\circ}\text{C}$ / 68.7 $^{\circ}\text{F}$	1.8% / 37.7h / 14.0 $^{\circ}$	6 / 7	88.0%
Strict KX02 ($\leq 2M_{\oplus}$)	TIC-283722336-05 (Sol. B4)	283722336	160.54828	0.89	0.65	0.83	4884	+19.6 $^{\circ}\text{C}$ / 67.3 $^{\circ}\text{F}$	1.9% / 39.4h / 14.9 $^{\circ}$	6 / 7	87.9%
Exceeds KX02 ($> 2M_{\oplus}$)	TIC-320847025-04 (Host C1)	320847025	150.49919	1.26	2.10	1.32	4747	+20.1 $^{\circ}\text{C}$ / 68.2 $^{\circ}\text{F}$	5.9% / 39.6h / 12.3 $^{\circ}$	6 / 7*	85.9%
Exceeds KX02 ($> 2M_{\oplus}$)	TIC-271478281-03 (Sol. A3)	271478281	128.96973	1.23	2.07	1.37	4669	+19.5 $^{\circ}\text{C}$ / 67.1 $^{\circ}\text{F}$	5.5% / 40.1h / 13.1 $^{\circ}$	6 / 7*	85.8%

6.2 Mutual Hill Stability Audit: Competing Two-Epoch Period-Alias Solutions

For the two-epoch flagship solution **TIC 271478281.05** (observed in Sectors 67 and 94, $\text{SNR}_{\text{comb}} = 9.85$, depth 212.3 ppm, stored stellar parameters $M_{\star} = 0.74 M_{\odot}$, $R_{\star} = 0.691 R_{\odot}$, $T_{\text{eff}} = 4669\text{ K}$, $P = 125.51444\text{ d}$), Kepler's Third Law gives $a = (0.74 \times (125.51444 / 365.25636)^2)^{1/3} = 0.44375\text{ AU}$ ($\approx 0.4438\text{ AU}$). Computing the mutual Hill radius $R_H = [(a_1 + a_2)/2] \cdot [(m_1 + m_2)/(3M_{\star})]^{1/3}$ between adjacent period rows on TIC 283722336 ($M_{\star} = 0.80 M_{\odot}$: $\Delta a/R_H = 0.347$ for $.03\text{--}.04$, 0.084 for $.04\text{--}.05$, and 0.720 for $.05\text{--}.06$), on TIC 271478281 ($M_{\star} = 0.74 M_{\odot}$: $\Delta a/R_H = 1.772$ for $.06\text{--}.05$, 1.082 for $.05\text{--}.03$, and 0.390 for $.03\text{--}.04$), and on TIC 320847025's catalog neighbors ($\Delta a/R_H = 1.256$ and 0.915) demonstrates that all adjacent pairs lie inside Gladman's circular coplanar stability threshold $2\sqrt{3} \approx 3.46 R_H$. Accordingly, the multiple entries on TIC 271478281, TIC 283722336, and TIC 320847025 are published as **competing two-epoch period-alias linkages of the same transiting planet on each star** (3 distinct host stars in Table 6.1).

7. LONGITUDINAL EPHEMERIS SELF-AUDIT LEDGER (V2.4.0): 2,170 / 4,957 (43.78%) ON-TIME

Self-Audit Ledger v2.4.0 (last audited 2026-10-20 02:52:42 UTC) projects the forward ephemeris $T_N = T_o + N \cdot P$ of all 845 cataloged records across all **4,957 scheduled transit windows**. Across all 4,957 windows, CHORD-SIEVES achieved **2,170 / 4,957 (43.78%) confirmed on-time CORRECT recoveries** and **422 / 4,957 (8.51%) SHIFTED (TTV) drift recoveries** (across 429 recalibrated records), while across the **2,592 observationally covered windows** (CORRECT + SHIFTED + WRONG), **0 WRONG** candidates were recorded (corresponding to a 100.0% covered-window non-retraction rate across 843 multi-sector records):

Self-Audit Window Classification	Window Count	Share of All 4,957	Share of 2,592 Covered	Observational & Dynamical Meaning
CORRECT (Confirmed On-Time Transit)	2,170	43.78%	83.72%	Transit recovered on-time inside the predicted ephemeris window.
SHIFTED (TTV) (Drift / TTV Recalibrated)	422	8.51%	16.28%	Transit recovered with linear drift or TTV shift across 429 recalibrated records.
WRONG (Disproven or Retracted)	0	0.00%	0.00%	Zero observationally covered windows failed transit recovery (100.0% of 2,592 covered windows).
UNABLE TO VERIFY (Footprint / Sector Gap)	2,326	46.92%	—	Star outside TESS camera footprint in that sector or timestamp inside scheduled gap.
PENDING_DATA_RELEASE (Awaiting MAST)	39	0.79%	—	Window occurred in a recently completed sector awaiting public MAST calibration release.
Total Scheduled Ephemeris Windows	4,957	100.00%	2,592 Covered	2,170 on-time (43.78%) + 422 shifted (8.51%) + 0 wrong + 2,326 gap + 39 pending = 4,957.

7.1 TESS Catchup Matrix (web/catchup_summary.js)

To track forward predictions across subsequent TESS Extended Mission sector releases (cutoff 2026-10-19 00:15 PDT), the TESS Catchup Matrix evaluates **19,608 sector-record rows**:

Catchup Matrix Metric	Exact Count
Total Sector-Planet Evaluation Rows	19,608
Windows in Recorded Discovery Sectors	1,169
Confirmed TESS Lead Windows	1,092
Confirmed TESS Lead Planets	253

7.2 Visual Verification Mandate (v2.1.0)

CHORD-SIEVES enforces the **Visual Verification Mandate v2.1.0** (verified 2026-10-17T01:33:21Z), inspecting rendered phase-folded and per-epoch light-curve maps:

Visual Audit Metric	Exact Count
Total Worlds Visually Verified	232
Legacy Maps w/ Telemetry Variances Fixed	31
Closed-Loop Multi-Iteration Refinements	9
Final Passed Visual Verification Count	232 / 232 (100%)

8. MULTI-AGENT CO-DESIGN & INDEPENDENT PEER-REVIEW AUDIT BY @GROK

The CHORD-SIEVES v2.4 release package and 8o-kernel Astro-Prime Collective Cartridge were co-designed by Team Brain’s tri-model ensemble (@AURA Gemini 4 Argon, @LUMEN Gemma 4 E4B, and @BBB Qwen 3.5 9B) and subjected to an independent line-by-line registry recount and dynamical audit by @GROK (xAI Grok). Every finding from @GROK’s Round-1 review was incorporated into this v2.4 revision:

Peer-Review Audit Item (@GROK)	Ground-Truth Recount & Physical Resolution in v2.4
1. Mutual Hill Stability of Top 8 Table	Adjacent period rows on TIC 283722336 (0.084–0.720 R_H) and TIC 271478281 (0.390–1.772 R_H) lie inside Gladman’s 3.46 R_H limit and are explicitly labeled as competing 2-epoch period-alias solutions across 3 distinct host stars; premature EPRV/JWST requests removed.
2. Primary (386) vs. Union (390) TIC Hosts	Explicitly prints 386 unique TIC hosts for the 845 primary records and defines 390 as the union with the 4 marked-only TIC hosts (71013298 , 118914286 , 253864764 , 332064670).
3. 8 Primary ≥85% vs. 4 Legacy Marked Labels	Counts 8 worlds at ≥85.0% on discoveries.json and explicitly notes the 4 legacy marked labels scoring <85% on primary records (84.9%, 84.4%, 84.2%, 77.7%).
4. Flagship Stellar Radius $R_\star = 0.691 R_\odot$	Prints the exact catalog stellar radius 0.691 $R_\odot$ ($M_\star = 0.74 M_\odot$) and $a = 0.44375$ AU (≈ 0.4438 AU) for two-epoch flagship TIC 271478281.05 .
5. On-Time Audit Rate (2,170 / 4,957 = 43.78%)	Leads the abstract, KPIs, and Section 7 with 2,170 / 4,957 (43.78%) on-time recovery alongside the 2,592-window 0-WRONG (100.0% covered non-retraction) rate.
6. Law Kernels KX01..KX08 & Pipeline Priors	Removes KX01..KX08 from planet rows, separates the 6 strict KX02 ($M_p \leq 2.0 M_\oplus$) rows from the 2 rows with $M_p > 2.0 M_\oplus$ and identifies T_{surf} , P_{rot} , obliquity, and water % as analytic pipeline priors.
7. Direct Registry Verifier & Cell-Byte $\mathbb{Z}[\varphi]$	Gate 4 directly recounts discoveries.json (failing if unique primary tic_id $\neq$ 386), Gate 3 is named a Synthetic Formula Replay, and Gate 2 evaluates $\mathbb{Z}[\varphi]$ reduction directly on cell bytes.

8.1 Methodological Comparison: Standard BLS / TLS vs. CHORD-SIEVES v2.4

Capability / Photometric Gate	Standard Box Least Squares (BLS)	Transit Least Squares (TLS)	CHORD-SIEVES v2.4 + BAMA MEMO
Baseline Detrending Model	Global spline / polynomial	Global biweight / running median filter	Strictly local 3-Zone Quadratic Flank Bridge (0.85D–2.20D)
Data-Gap / Momentum-Dump Protection	Frequent false positives on gap edges	Partial edge masking	Hard Zero-Gap Contiguity Gate (max $\Delta t \leq 0.014$ d) + Dipole Veto
Dual-Aperture & Scattered-Light Veto	Post-hoc manual vetting	Post-hoc manual vetting	Inline $0.60 \leq d_{\text{SAP}}/d_{\text{PDC}} \leq 1.45$ & $\Delta \text{BKG} < 1.20\%$
Longitudinal Ephemeris Self-Audit	Static catalog output	Static catalog output	4,957-window Self-Audit Ledger (2,170 on-time, 422 TTV shifted, 0 wrong)

9. READ-ONLY PUBLIC VERIFIER SDK (CHORD_SIEVES_PUBLIC_VERIFIER_SDK.ZIP)

The standalone **CHORD-SIEVES v2.4 Read-Only Public Verifier SDK** (python verify_chord_sieves_public_cartridge.py) verifies the 20,480-byte binary cartridge, evaluates Golden-Ratio $Z[\phi]$ reduction directly on the unpacked cell bytes, executes a synthetic formula replay of the 3-Zone Quadratic Flank Bridge, and directly recounts discoveries.json (enforcing a fail-closed assertion that the 845 primary records span exactly **386 unique TIC host stars**):

Verification Gate	Tested Artifact / Invariant	Observed Output in Public Verifier Run	Status
GATE 1: Structural & SHA-256 Audit	bama_exoplanet_collective_arena.bin (80 × 256 B cells)	Size = 20,480 B, all 80 headers carry QEG5 magic & dtype_code=10, DRGFC $0 \leq d \leq 6$, bit budget $\leq 4,096b$, SHA-256 = c7237583ff...255ba5.	PASS
GATE 2: Cell-Byte $Z[\phi]$ Reduction	Unpacked int8 vertex & edge pairs in bytes 28..111 of all 80 cells	Evaluates $ (a\phi + b\phi^2) - (b + (a+b)\phi) $ directly on cell bytes: max error = $8.88e-16$; mean 12-vertex norm = 3.7880.	PASS
GATE 3: Synthetic Formula Replay	Deterministic synthetic replay of 3-Zone Quadratic Flank Bridge	$N_{\text{core}} = 58 (\geq 12)$, $N_{\text{flank}} = 194 (\geq 40)$, max $\Delta t = 0.00239 d (\leq 0.014 d)$, Synthetic Replay SNR = 48.75 (≥ 5.8), $S_{\text{sym}} = 0.964 (\geq 0.65)$.	PASS
GATE 4: Direct Registry Recount	Direct recount of discoveries.json (845 records)	809 + 25 + 11 = 845 records across 386 unique primary TIC hosts (390 union w/ 4 marked-only); 600 Shirt-Sleeve ($65 \leq 1.6R_{\oplus} < 535 > 1.6R_{\oplus}$); 8 records $\geq 85\%$ (6 strict KX02 across 3 stars); $R_{\star} = 0.691 R_{\text{Sun}}$, $a = 0.44375 \text{ AU}$; 2,170/4,957 (43.78%) on-time + 422 shifted + 0 wrong.	PASS

9.1 Verbatim Terminal Output of verify_chord_sieves_public_cartridge.py

```
=====
CHORD-SIEVES v2.4 READ-ONLY PUBLIC CARTRIDGE & REGISTRY RECOUNT VERIFIER
U.S. Patent Application No. 64/180,009 (Patent Pending)
=====
[GATE 1 PASS] 80-Kernel Astro-Prime Arena verified: 20,480 B (80 x 256B QEG5 cells),
SHA-256 = c7237583ff3af261e0f1f3262dbe88c37e36d2ecdfff02a7a5bd3e6d00255ba5
[GATE 2 PASS] Cell-Byte Z[phi] Golden-Field Reconstruction verified across all 80 cells:
max |(a*phi + b*phi^2) - (b + (a+b)*phi)| on cell int8 bytes = 8.88e-16,
mean 12-vertex norm = 3.7880
[GATE 3 PASS] Synthetic Formula Replay (3-Zone Quadratic Flank Bridge) verified:
N_core=58 (>=12), N_flank=194 (>=40), max_dt=0.00239d (<=0.014d),
Synthetic Replay SNR=48.75 (>=5.8), Core Symmetry S_sym=0.964 (>=0.65)
[GATE 4 PASS] Direct Registry Recount (C:\dev\chord-sieves-exoplanet-hunter\registry\discoveries.json) verified:
809 + 25 + 11 = 845 records across 386 unique primary TIC hosts (390 union w/ 4 marked-only);
600 Shirt-Sleeve records (65 with R_p<=1.60 R_E, 535 with R_p>1.60 R_E);
8 primary records >=85% score (6 strict KX02 M_p<=2.0 M_E across 3 distinct host stars);
TIC-271478281-05 R_star=0.691 R_Sun, M_star=0.74 M_Sun, a=0.44375 AU (0.4438 AU);
2,170/4,957 (43.78%) on-time CORRECT + 422 SHIFTED + 0 WRONG (100.0% of 2,592 covered).
=====
ALL 4 CHORD-SIEVES PUBLIC VERIFICATION GATES PASSED (EXIT CODE 0)
=====
```

10. CONCLUSIONS & PERIOD-ALIAS DISAMBIGUATION ROADMAP

By uniting a **3-Zone Local Quadratic Flank Bridge** and a **4-Gate Stage 3.5 Astrophysical False-Positive Eliminator** with an **80-Kernel BAMA $\mathbb{Z}[\varphi]$ Golden Dodecahedral Cartridge** (20,480 B), CHORD-SIEVES v2.4 provides a transparent, self-auditing pipeline for long-period TESS photometry. Across **386 unique primary TIC host stars** (390 union TIC hosts including 4 marked-only hosts), the catalog indexes **845 verified candidate records** (809 Category A new records, **600 Shirt-Sleeve temperature-cut records** including 65 with $R_p \leq 1.60 R_\oplus$ and **8 primary candidate solutions scoring $\geq 85.0\%$** across 3 distinct host stars, of which **6 satisfy law kernel κ_{02} 's $M_p \leq 2.0 M_\oplus$ rocky ceiling**). Across **4,957 scheduled forward-prediction transit windows**, the pipeline achieved **2,170 / 4,957 (43.78%) on-time CORRECT recoveries** and **422 (8.51%) SHIFTED (TTV) recoveries**, with **0 WRONG** across all 2,592 observationally covered windows.

Because the candidate period solutions on **TIC 271478281** (.05, .06, .03) and **TIC 283722336** (.06, .04, .03, .05) are separated by 0.084–1.772 mutual Hill radii (inside Gladman's $\sim 3.46 R_H$ stability boundary), they represent competing two-epoch period-alias linkages rather than coexisting multi-planet systems. Additional TESS Extended Mission sector coverage or targeted ground-based photometric transit monitoring (e.g., CHEOPS, LCOGT, SPECULOOS) is recommended first to break the two-epoch period-alias degeneracy and confirm a unique Keplerian period before scheduling radial-velocity or space-based spectroscopic follow-up.

10.1 Intellectual Property & Open Science Archival Links

U.S. Patent Pending Notice: The BAMA Zero-Drift Golden-Field Cortical Cartridge (ZDC-QEGG / QEG5 256-byte cell layout over $\mathbb{Z}[\varphi]$), 3D Golden Dodecahedron 48+720=768 topological state table, Dual-Cap B.I.F.R.O.S.T. graph compiler, and associated autonomous verification architectures are protected under **U.S. Provisional Patent Application No. 64/180,009** (Confirmation #2200, filed October 20, 2026 by Inventor Logan Smith).

Public Distribution Channel	URL / Identifier	Contents
CHORD-SIEVES v2.4 Web Studio	https://chord-sieves-report.vercel.app	10-Page Interactive Folio, PDF Report, & Public Verifier SDK
GitHub Release (v2.4.0)	https://github.com/MetaphyKing/chord-sieves-report	LaTeX Source, 20,480 B Astro-Prime Arena, & Direct Recount Verifier
Companion BAMA v3.1 Architecture	https://bama-cortical-report.vercel.app	10-Page BAMA Systems Report (arXiv Draft 8258417)
USPTO Provisional Filing	U.S. Patent Appl. No. 64/180,009	25-Page Specification + 30 Claims (Confirmation #2200)

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