# The K = 7 Closure–Born–TPB Renewal Construction in VERSF

*A record-preserving recurrent instrument, a transparent 102-dimensional carrier census, and a reduction of the remaining full-carrier provenance problem.*

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**Designation:** K7-CBR-1 · Conditional Structural Construction / Numerical Provenance Stress Test

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**Headline result.** K = 7 closure, Born conditional selection and TPB renewal assemble into a complete record-preserving recurrent instrument. The construction removes the artificial long-history shutdown of the one-shot FCHI branch and restores non-zero neutral information flow. It is an *existence-and-capacity* result — not a proof that the primitive substrate uniquely forces the present 102-dimensional carrier, reset map, hazards or field pullback.

| Audit item | Verdict | Meaning |
|---|---|---|
| K = 7 closed-loop architecture | **IMPORTED** | Triangular/Fano sector inherited; the full loop-to-record attaching map is still open. |
| 102-dimensional retained carrier | **REPRODUCED** | The declared gauge/generation/species/neutral/parent-lift census gives 102 exactly. |
| Born conditional destination weights | **PASS** | Squared moduli of the supplied same-action polar support maps give normalised route weights. |
| Record-preserving renewal instrument | **PASS** | A ten-outcome instrument reopens the working carrier while retaining the fact in the ledger. |
| Long-history neutral information | **RESTORED** | Recurrent neutral edge-score Fisher rank is 21, not 0. |
| Old asymptotic rank obstruction | **REMOVED IN PRINCIPLE** | The K7 × recurrent process has rank 867, above the required non-terminal rank 96. |
| TPB hazard and absolute clock | **OPEN** | The benchmark $p = 1 - e^{-1}$ is inherited, not derived from a physical waiting-time law. |
| Primitive full-carrier provenance | **OPEN** | Attaching map, reset map, 102-coordinate Jacobian and full cross-block Hessian unreturned. |
| **Overall K7-CBR-1 grade** | **PARTIAL SUCCESS** | A viable recurrent architecture is constructed; unconditional uniqueness remains open. |

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# General reader summary

The immediate problem is simple to state. The existing full-carrier construction can describe one neutral completion event: an active state moves to a singlet-like completion stage, then to a completed record. But the completed record was treated as absorbing. Once one fact had formed, the neutral part of the model stopped producing further events. That is suitable for studying one episode; it cannot be the complete history law of a universe in which facts keep forming.

The repair combines four ideas already present in different parts of the programme. The $K = 7$ closure sector determines which loops form stable facts. Coarse-graining and species typing generate the larger effective carrier. The Born rule fixes the relative probabilities of the allowed completed outcomes. Ticks-Per-Bit (TPB) fixes *when* a new irreversible transition occurs. The additional move is **record-preserving renewal**: after a fact completes, its label is appended permanently to the ledger while the working carrier reopens to form the next fact.

This paper constructs that mechanism explicitly. The old seven-outcome neutral instrument becomes a ten-outcome recurrent instrument — one no-jump outcome, three active→singlet outcomes, three singlet→record outcomes, and three record-and-renew outcomes. The operators satisfy completeness to residuals $\approx 10^{-15}$ at two regulator levels, and all nine working states belong to one recurrent class rather than ending in three absorbing records.

The result also demystifies the phrase "102-dimensional instrument." The 102 is not a count of primitive ingredients; it is the retained real dimension after combining six history defects, six non-constant $K = 7$ bath modes, three gauge factors with auxiliaries, a $3\times3$ completion sector, charged and neutral parent lifts, and three complex completed-record directions. Under the declared census the count is exact: $12 + 6 + 18 + 36 + 24 + 6 = 102$. $K = 7$ is necessary to this count, but not sufficient by itself.

The most important numerical change is that neutral information no longer dies after one event. In the absorbing branch the asymptotic neutral Fisher rank was 0; in the recurrent branch it is 21. Multiplied by the 31 positive $K = 7$ history marks, the population edge-score process reaches rank 867 — ample capacity for a rank-96 pullback, so the previous rank obstruction to the non-terminal 102-dimensional Hessian is removed in principle.

The phrase "in principle" carries weight. The calculation demonstrates a viable architecture; it does not prove unique primitive provenance. The current sources do not yet enumerate every $K = 7$ loop belonging to each physical record class, do not uniquely derive the completed-record reset map, do not derive the physical TPB waiting-time laws, and do not return the full Jacobian from primitive marked histories to all 102 retained coordinates. The next task is therefore not to invent another full matrix; it is to derive those four maps from one common primitive history action and see whether the present recurrent instrument is returned or superseded.

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# Contents

## Abstract

The FCHI-1 retained construction supplies a positive 102-dimensional full-carrier parent and a complete $K = 7$ history × neutral terminal instrument, but its neutral working law is episodic: completed records are absorbing, so the asymptotic neutral marked information rate vanishes. We test a provenance decomposition in which $K = 7$ closed histories define admissible fact classes, coarse-grained geometry and species typing generate the retained carrier, Born weights select among admissible outcomes, and TPB first-passage statistics determine event timing. The completed record is preserved in an external ledger while the working neutral carrier is renewed, converting the supplied seven-outcome neutral instrument into a complete ten-outcome recurrent instrument.

At regulator levels 3 and 4 the recurrent instrument has completeness residuals $1.11 \times 10^{-15}$ and $9.99 \times 10^{-16}$. Under the controlled benchmark $p\_D = p\_R = p\_B = 1 - e^{-1}$, the nine working states form one closed recurrent class, the stage fractions are 1/3 each, the mean record cycle is $3e/(e - 1) = 4.745930120608$ proto-ticks, and the completed-record rate is $(e - 1)/3e = 0.210706852943$ per proto-tick. The same-action polar support maps give a nearly key-preserving active-to-record transition with maximum off-diagonal probability $7.36 \times 10^{-6}$. The asymptotic neutral population edge-score Fisher rank rises from 0 (absorbing) to 21 (recurrent). The $K = 7$ × recurrent product law has 310 factorised outcomes and rank 867, removing the previous rank-based impossibility of a rank-96 non-terminal pullback.

The result is a conditional structural construction and numerical capacity certificate. It does not derive the primitive loop-to-record attaching map, the renewal/reset map, finite-mean TPB hazards, the full 102-coordinate defect-to-mark Jacobian, or the physical cross-block Hessian. Primitive full-carrier provenance therefore remains open.


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## Principal claim

Given the imported $K = 7$ closure sector, the declared gauge/generation/species census, the supplied same-action polar support maps, and finite-mean TPB waiting laws, there exists a complete record-preserving recurrent marked instrument whose long-history neutral information rate is non-zero and whose $K = 7$ product process has sufficient Fisher-rank capacity for the 96 non-terminal directions of the FCHI parent. This is an **existence-and-capacity theorem conditional on named inputs**, not an unconditional uniqueness theorem.

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## Provenance of inputs and new contributions

| Category | Content | Epistemic grade |
|---|---|---|
| Imported structural return | Closed loops, triangular irreducibility, K = 7/Fano coherence architecture. | Conditional on the source theorem and its attaching-map caveat. |
| Imported temporal return | TPB as first-passage/renewal structure; facts as ongoing committed-record accumulation. | Detailed waiting-time law remains a modelling input. |
| Imported probability return | Quadratic Born selection on reversible path-correlation classes. | Used as a conditional programme theorem. |
| Imported full-carrier return | FCHI 102-dimensional census, level-3/4 support maps, frozen matrices. | Structurally complete but supplied, not uniquely derived. |
| **New construction** | Record-preserving C→A renewal and the ten-outcome neutral instrument. | Derived and executed here. |
| **New numerical certificate** | Stationarity, completeness, regulator drift, Fisher-rank comparison. | Reproducible from the attached package. |
| Benchmark only | $p\_D = p\_R = p\_B = 1 - e^{-1}$. | Inherited event-normalised benchmark; no TPB derivation claimed. |
| Still open | Attaching map, physical reset, finite-mean hazards, full Jacobian, cross-block Hessian. | These define the remaining provenance theorem. |

# Part I — Problem, source boundary and proposed synthesis

## 1. The one-shot history problem

FCHI-1 answered an existence question: can the charged/gauge and neutral terminal carriers coexist inside one positive finite-regulator retained parent with a complete record instrument? At the declared quadratic order the answer is yes — a 102-dimensional real parent, a 31-operator K = 7 history instrument, a seven-outcome neutral instrument, positive active-to-singlet support, singlet self-completion, and an exact regulator-independent route gap. It did not claim that the primitive MASD/HMGBC law uniquely produces those objects [10].

The later complete marked-return audit exposed a different issue. The neutral instrument was evaluated as a single absorption episode: once an active state reached a completed record, no further neutral mark occurred. The finite episode carried information, but the *long-history* neutral information rate vanished. On a completed terminal orbit the neutral score block was zero, and the total asymptotic marked Fisher rank was too small to reproduce the rank-96 non-terminal FCHI Hessian by any pullback [12].

**Interpretive firewall.** That failure did not show neutral completion is impossible. It showed that a one-shot completion instrument had been used as though it were the full recurrent history law. An absorbing episode and a universe-wide fact-production process are not the same mathematical object.

# 2. The proposed decomposition

The repair separates four questions that had been mixed:

- **Allowedness** — which reversible histories close into admissible persistent facts?
- **Carrier generation** — which effective degrees of freedom must be retained after coarse-graining and species typing?
- **Selection** — conditional on a commitment occurring, which admissible outcome is realised?
- **Timing** — how many primitive ticks elapse before the next commitment and completed record?

K = 7 closure addresses allowedness; the coarse-graining and Standard Model census address the retained carrier; the programme Born construction addresses conditional selection; TPB renewal addresses timing; a record-preserving reset joins successive episodes without deleting past facts:

K = 7 histories → closure classes $\boldsymbol{\mathcal{R}}$_A → retained carrier → Born weights $\mathbb{P}(A)$ → TPB hazard h_X(a) → record-preserving renewal → (persistent ledger). **(1)**

*Figure 1.* Logical separation of allowedness, coarse-grained carrier generation, Born conditional selection and TPB renewal. The persistent ledger stores completed facts while the working carrier reopens — the single closed loop in the diagram runs A → S → C → (ledger ⊕ i) → A.

# 3. Source and claim boundary

This paper is deliberately not a fresh derivation of every upstream ingredient. It consumes the corpus in a restricted way: the K = 7 papers provide a triangular closure sector and a seven-constraint coherence architecture while acknowledging the attaching-map construction is open [1]; the TPB papers provide first-passage/renewal language while grading the scale-free tail as a modelling hypothesis [3]; the Double Square paper provides the conditional quadratic selection law [5]; the exact-projection and full-operator papers establish that non-orthogonal overlap and cross-kernel terms are structurally important [6,7]; FCHI provides the retained census and same-action polar maps [10].

The new contribution is therefore narrow but load-bearing: assemble these ingredients into a recurrent record-preserving instrument, execute it at two regulator levels, and determine whether the previous long-history rank obstruction survives. It does not.

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# Part II — K = 7 closure histories and physical record classes

## 4. Closed loops as the fact-admissibility condition

The imported K = 7 analysis argues that curvature detection requires closed loops, that locally composable loops of length four or more decompose into triangles, and that the triangle is the minimal irreducible curvature-bearing loop; robust fact formation then requires a seven-constraint coherence encoding with Fano-plane combinatorics [1]. These motivate a path groupoid $\mathcal{P}_7$ of reversible K = 7 histories.

A physical fact cannot be an arbitrary path. It must close, carry an admissible holonomy or syndrome, survive the coherence and error-correction test, and leave a stable observer-invariant record. For a candidate terminal record class A, define the first-closure history class

$\mathcal{R}$_A = { $\gamma \in \mathcal{P}_7$ : $\gamma$ first closes into persistent record class A }. **(2)**

This separates the *existence* of reversible paths from the *irreversible admission* of a fact. It also fixes the domain on which the Born path-pair rule acts: the probability of A is computed over the reversible histories that close into A, not over arbitrary substrate paths.

## 5. The attaching-map debt

Equation (2) is a correct *target definition*, not yet an exhaustive enumeration. The source loop theorem does not supply the complete attaching map from primitive triangular histories to every charged, neutral, gauge and terminal record class; in particular it does not by itself prove the three-generation neutral roster or the right-handed-singlet completion branch. This is precisely why the earlier provenance audit found the primitive wheel compatible with both a charged-minimal and a neutral-extended representation ledger [11].

**Proposition 1 (allowedness before probability).** A Born weight can be assigned only after the physical record classes $\mathcal{R}$_A are defined. The quadratic rule fixes relative weights among admitted closure classes; it cannot create the closure classes or select the neutral roster by itself.

The full provenance theorem must therefore compute the attaching map *before* claiming the present neutral terminal instrument is unique. This paper keeps that debt exposed rather than treating the supplied FCHI labels as primitive facts.

## 6. Persistent records and successive facts

The Tick-Bit and fact-production papers describe time as the ordered accumulation of committed records rather than a background parameter [2,4]. A completed record is therefore not a disposable working state: it remains in the ledger and conditions later histories. At the same time, fact production must continue — a closed record cannot absorb the entire future of the worldline. The required operation is not "erase C and return to A" but "**append the label carried by C to the persistent ledger, then reopen the working carrier**," which makes renewal compatible with irreversible commitment.

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# Part III — The conditional 102-dimensional retained carrier

## 7. Why 102 is an emergent census, not a primitive count

FCHI's 102 is the real dimension of a retained quadratic carrier assembled after truncation, mode selection, species typing, realification and minimal parent lifting [10]. It decomposes as:

| Retained block | Structural formula | Dim. | Dependency |
|---|---|---|---|
| history defect + unresolved bath | 6 MASD defects + (K−1) non-constant K7 bath modes | **12** | K = 7 plus the six-defect MASD truncation |
| gauge direct + auxiliary response | 2 × 3 connected gauge factors | **6** | SM gauge census + one relaxation coordinate per factor |
| generation-address completion | 2 (realification) × 3 generation × 3 address modes | **18** | three-generation census + rank-three address response |
| charged left–right parent | 2 (realification) × 2 (parent sides) × 3 generations × 3 charged sectors | **36** | u,d,e charged census + minimal Hermitian parent lift |
| neutral Nambu parent | 2 (realification) × 2 (parent sides) × 3 generations × 2 neutral endpoints | **24** | $\nu_L + N_R$ neutral-completion branch |
| completed neutral record | 2 (realification) × 3 generation-keyed records | **6** | one persistent complex record direction per generation |
| **Total** | 12 + 6 + 18 + 36 + 24 + 6 | **102** | matches both frozen FCHI regulators |

12 + 6 + 18 + 36 + 24 + 6 = 102. **(3)**

## 8. Conditional carrier-census theorem

**Theorem 1 (conditional 102-dimensional census).** Given K = 7, the six-defect MASD truncation, the three connected gauge factors with one auxiliary response coordinate each, three generations, the u/d/e charged census, the $\nu_L + N_R$ neutral branch, complex realification and the declared minimal parent lifts, the retained real carrier dimension is 102.

The proof is the direct product-and-sum count above. Its value is epistemic: the count is transparent and falsifiable. Its limitation is equally sharp — **$K = 7$ alone does not imply 102**. Removing $N_R$ changes the neutral and completed-record blocks; changing the generation or species census changes the count. Full provenance therefore requires the primitive attaching map and terminal-orbit enumeration to recover the same roster *without importing it*.

## 9. Exact projection and the cross-block warning

The exact-projection paper proves that non-orthogonal closure modes must be read with the dual basis, $q = M^{-1}b$, not the naive overlap vector b [6]. The full projected-operator paper shows adjacent overlaps are large and that omitted cross-kernel and next-neighbour terms materially shift the spectrum [7]. Together they warn that a block-diagonal 102-dimensional matrix is admissible **only after every allowed cross-block has been computed and shown to vanish or take its returned value**. The earlier provenance stress test constructed positive off-diagonal completions with the same diagonal blocks but different transfer operators [11]. The present paper removes the absorbing-history rank obstruction; it does not by itself determine those cross-blocks.

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# Part IV — Born conditional selection from closure support

## 10. Path-pair probability on admitted record classes

Within the Double Square construction each reversible path P carries a geometric phase $\theta(P)$, the amplitude for record class A is the path sum over $\mathcal{R}_A$, and irreversible selection acts on pairwise path correlations. Under the stated positivity, normalisation, relabelling and factorisation conditions the conditional outcome law is quadratic [5]:

$\psi_A = \Sigma_{(P \in \mathcal{R}_A)} e^{i\theta(P)}$, $\mathbb{P}(A \mid \text{commitment}) = |\psi_A|^2 / \Sigma_B |\psi_B|^2$. **(4)**

Equation (4) determines relative outcome weights *after* the admissible record classes are identified. It says nothing about the waiting time to commitment, and it does not fix the magnitude of the completion response — that is retained by the positive strain operators in the same-action polar decompositions.

## 11. Support and strain in the supplied neutral maps

For the supplied regulator-level neutral completion matrices, take the polar decompositions

$Y_\nu^\dagger = U_D S_D$, $M_R^\dagger = U_R S_R$. **(5)**

The positive factors $S_D$, $S_R$ retain hierarchy and response magnitude; the unitary factors $U_D$, $U_R$ determine coherent route support. The population-level Born maps are

$$B_D(j|i) = |(U_D)_{ji}|^2, \quad B_R(k|j) = |(U_R)_{kj}|^2. \quad \textbf{(6)}$$

Both maps are doubly stochastic to residuals below $1.3 \times 10^{-15}$. The full active-to-record population map is $B_{cycle} = B_R B_D$. At level 3:

| **Source ╲ record** | **C1** | **C2** | **C3** |
|---|---|---|---|
| **A1** | 0.9999961166 | $3.852 \times 10^{-6}$ | $3.151 \times 10^{-8}$ |
| **A2** | $3.853 \times 10^{-6}$ | 0.9999887895 | $7.358 \times 10^{-6}$ |
| **A3** | $3.066 \times 10^{-8}$ | $7.359 \times 10^{-6}$ | 0.9999926107 |

The map is overwhelmingly key-preserving but not exactly diagonal; its largest cross-key probability is $7.36 \times 10^{-6}$. This small mixing is responsible for the very slow but non-zero inter-key equilibration of the recurrent benchmark.

## 12. Born selection does not fix event timing

**Logical separation.** Born probability answers "which admitted record class is selected, conditional on commitment?" TPB answers "when does the next commitment occur?" Multiplying the two is justified by conditional probability; substituting one for the other is not.

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# Part V — TPB timing and record-preserving renewal

## 13. General TPB hazard law

Let X denote a transition stage and a its age in primitive ticks. If $S_X(a)$ is the survival probability through age a, the discrete hazard is

$$h_X(a) = 1 - S_X(a + 1) / S_X(a). \quad \textbf{(7)}$$

For an admitted route $i \to j$ with conditional Born matrix $B_X$, the complete marked law factorises:

$$\Pr[X, i \to j \text{ at age } a] = h_X(a) \cdot B_X(j|i), \quad \Pr[\text{no event at age } a] = 1 - h_X(a). \quad \textbf{(8)}$$

**Theorem 2 (closure/Born/TPB factorisation).** Once the allowed route set and the conditional destination matrix $B_X$ are fixed, any age-dependent event law factors as the stage hazard

$h\_X(a)$ times the conditional destination probability $B\_X(j|i)$. Closure fixes the support, TPB fixes the event hazard, Born selection fixes the conditional destination weights.

The theorem is a conditional-probability identity; its physical content lies in the *source* of each factor. A provenance proof must derive $h\_X$ from the primitive clock/renewal law and $B\_X$ from the admitted closure histories, not fit either after the fact.

# 14. The record-preserving renewal map

Let $A\_i$, $S\_i$, $C\_i$ denote active, singlet-completion and completed-record working states for generation key i, and $|\ell\rangle$ the persistent ledger. The minimal key-preserving renewal isometry is

$|C\_i\rangle|\ell\rangle \to |A\_i\rangle|\ell \oplus i\rangle$, **(9)**

where $\ell \oplus i$ appends the completed label i to the ledger. Equation (9) is **not erasure**: the working carrier is renewed while the fact survives as a permanent orthogonal ledger mark.

*Figure 3.* Three-stage record-production cycle $A\_i \to S\_i \to C\_i \to$ (append i to ledger) $\to A\_i$. TPB hazards set the timing of each stage; Born maps set the destination key; the C→A step appends the completed record to the persistent ledger.

# 15. Ten-outcome recurrent instrument

For constant stage probabilities $p\_D$, $p\_R$, $p\_B$, let $P\_A$, $P\_S$, $P\_C$ be the three working-stage projectors. Define one no-jump operator, three Dirac-route operators, three record-completion operators and three renewal operators:

$K_0 = \sqrt{(1 - p\_D)}\, P\_A + \sqrt{(1 - p\_R)}\, P\_S + \sqrt{(1 - p\_B)}\, P\_C$, **(10)**

$D\_i = \sqrt{p\_D} \cdot U\_D\, |i\rangle\langle i|\{A\to S\}$, $R\_i = \sqrt{p\_R} \cdot U\_R\, |i\rangle\langle i|\{S\to C\}$, **(11)**

$B\_i = \sqrt{p\_B} \cdot |A\_i\rangle\langle C\_i|$ (ledger mark i). **(12)**

Because the source projectors are orthogonal and the support maps are isometries on their source subspaces,

$K_0\dagger K_0 + \Sigma_i D\_i\dagger D\_i + \Sigma_i R\_i\dagger R\_i + \Sigma_i B\_i\dagger B\_i = I_9$. **(13)**

**Theorem 3 (recurrent-instrument completeness).** For any $p\_D, p\_R, p\_B \in [0,1]$ and unitary support maps $U\_D$, $U\_R$, the ten operators (10)–(12) define a completely-positive trace-preserving marked instrument on the nine-state working carrier, provided the $B\_i$ outcomes are recorded in an orthogonal persistent ledger.

The proof is equation (13) (see Appendix A.1). The ledger labels make the three renewal outcomes physically distinguishable records and reduce the irrelevant Kraus-unitary freedom to record-preserving transformations.

# 16. Finite-mean renewal and the long-run fact rate

For general age-dependent hazards let $m_D$, $m_R$, $m_B$ be the mean waiting times of the three stages, and $M = m_D + m_R + m_B$. The renewal-reward theorem gives

$r_{fact} = 1/(m_D + m_R + m_B)$, **(14)**

$\pi_A = m_D/M$, $\pi_S = m_R/M$, $\pi_C = m_B/M$. **(15)**

**Theorem 4 (recurrent stage law).** If the three stage waiting times have finite means, the record-production process has a non-zero long-run fact rate (14), and its stage occupation fractions are (15).

Under the symmetric benchmark of §18, each stage is geometric with success probability $p = 1 - e^{-1}$, so $m_D = m_R = m_B = 1/p$ and the closed forms are exact:

$M = 3/(1 - e^{-1}) = 3e/(e - 1) = 4.745930120608$, $r_{fact} = (1 - e^{-1})/3 = (e - 1)/3e = 0.210706852943$, $(\pi_A, \pi_S, \pi_C) = (⅓, ⅓, ⅓)$.

# 17. The scale-free TPB caveat

The TPB-entropy source uses an asymptotically scale-free first-passage tail but explicitly grades that tail as a modelling hypothesis [3]. If

$\Pr(\tau > n) \sim C n^{-\alpha}$, **(16)**

then, since $E[\tau] = \Sigma_{(n \geq 0)} \Pr(\tau > n)$, the mean is finite **iff $\alpha > 1$** unless a physical cutoff is present. Renewal language alone therefore does not guarantee a non-zero asymptotic rate: a finite local capacity, closure scale, certification scale, or faster tail must regularise the process. A finite-cutoff audit makes the boundary explicit:

| α | Cutoff ticks | Mean ticks/stage | Completed records/tick |
|---|---|---|---|
| 0.5 | 100 | 18.589604 | 0.017931 |
| 0.5 | 1000 | 61.801009 | 0.005394 |
| 0.5 | 10000 | 198.544645 | 0.001679 |
| 1.0 | 100 | 5.187378 | 0.064259 |
| 1.0 | 1000 | 7.485471 | 0.044531 |
| 1.0 | 10000 | 9.787606 | 0.034057 |
| 1.5 | 100 | 2.412874 | 0.138148 |

| α | Cutoff ticks | Mean ticks/stage | Completed records/tick |
|---|---|---|---|
| 1.5 | 1000 | 2.549146 | 0.130763 |
| 1.5 | 10000 | 2.592376 | 0.128582 |
| 2.0 | 100 | 1.634984 | 0.203876 |
| 2.0 | 1000 | 1.643935 | 0.202766 |
| 2.0 | 10000 | 1.644834 | 0.202655 |

For $\alpha = 0.5$ and 1.0 the apparent fact rate keeps falling as the cutoff moves outward; for $\alpha = 1.5$ and 2.0 it stabilises. The physical TPB law must therefore return either $\alpha > 1$ asymptotically or a finite substrate cutoff.

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# Part VI — Numerical execution and information return

## 18. Frozen inputs and benchmark convention

The execution consumes the frozen level-3 and level-4 FCHI retained matrices, the corresponding Dirac and Majorana polar support maps, the $K = 7$ irreversible history kernel, and the representation ledger. No experimental Standard Model or neutrino target is inserted. To isolate the effect of renewal, the stage probabilities are set to the old FCHI event-normalised benchmark

$p\_D = p\_R = p\_B = 1 - e^{-1}$, $q = e^{-1}$. **(17)**

**Benchmark status.** Equation (17) is **not** derived by TPB here. It is a controlled inherited benchmark used to compare the recurrent instrument with the old absorbing branch. A physical provenance theorem must replace it with the returned waiting-time law.

## 19. Recurrent neutral return

| Return | Value | Interpretation |
|---|---|---|
| Kraus outcomes | 10 | one no-jump, three D, three R, three record-renew |
| Working carrier dimension | 9 | three active, three singlet, three completed-record |
| Completeness residual, level 3 | $1.11 \times 10^{-15}$ | Pass |
| Completeness residual, level 4 | $9.99 \times 10^{-16}$ | Pass |

| Return | Value | Interpretation |
|---|---|---|
| Closed recurrent components | 1 | all nine working states communicate |
| Stage fractions | ⅓, ⅓, ⅓ | equal-hazard benchmark |
| Mean record cycle | $3e/(e - 1) = 4.745930120608$ proto-ticks | three geometric stages |
| Completed-record rate | $(e - 1)/3e = 0.210706852943$ per proto-tick | benchmark only |
| Spectral gap, level 3 | $1.03124 \times 10^{-6}$ | positive, slow inter-key mixing |
| Spectral gap, level 4 | $1.02738 \times 10^{-6}$ | positive, regulator stable |

The small spectral gap is not a completeness problem; it reflects the tiny off-diagonal Born route weights of §11. Under exact key preservation the recurrent process would split into three independent key-preserving classes instead of one slowly mixing class.

# 20. Regulator stability

- Dirac population map, max drift: $1.198 \times 10^{-7}$
- Record population map, max drift: $8.441 \times 10^{-8}$
- Renewal kernel spectral-norm drift: $1.177 \times 10^{-7}$
- Stationary distribution, max drift: $2.477 \times 10^{-10}$

Levels 3 and 4 therefore agree at the $10^{-7}$–$10^{-10}$ scale for the principal recurrent observables. This is a regulator-stability check on the supplied support maps and the renewal assembly, not a proof of the continuum physical branch.

# 21. Long-history information restoration

In the absorbing branch all asymptotic probability eventually sits in completed records and every neutral transition intensity vanishes. In the recurrent branch, active, singlet and completed working stages retain positive stationary weight, so the neutral edge-score Fisher information stays non-zero.

| Process | Coord. dim. | Rank | Nullity | Meaning |
|---|---|---|---|---|
| Neutral absorbing (asymptotic) | 27 | **0** | 27 | neutral marks stop after one fact |
| Neutral recurrent | 30 | **21** | 9 | only source-normalisation gauges remain null |
| K7 × absorbing (asymptotic) | 837 = 31·27 | **72** | 765 | history survives; neutral sector is dead |
| K7 × recurrent | 930 = 31·30 | **867** | 63 | all non-gauge edge directions are active |

*Figure 4.* The absorbing neutral branch has zero asymptotic edge-score rank. Record-preserving renewal restores neutral rank 21 and raises the $K = 7$ product rank from 72 to 867.

# 22. Removal of the previous rank obstruction

The non-terminal FCHI parent has rank 96. In the absorbing long-history law the neutral sector was asymptotically dead (rank 0), and even the full $K = 7 \times$ absorbing product reached only rank 72 — **below** the required 96 — so no field-to-mark Jacobian could reproduce that parent. The recurrent population edge-score process has rank 867. There is therefore no longer a rank-based impossibility of a 96-dimensional non-terminal pullback of

$H_{102} = J^T \mathcal{I}\_\text{path} J$. **(18)**

**Theorem 5 (rank-obstruction removal).** The $K = 7 \times$ recurrent population marked law has sufficient Fisher-rank capacity to support a rank-96 pullback. The earlier asymptotic rank no-go was a consequence of terminal absorption, not a general impossibility of the closure–Born–TPB architecture.

This is a **capacity** theorem only. Equation (18) becomes a *provenance* result only when the physical 102-coordinate defect-to-mark Jacobian J is computed from the primitive action:

**Proposition 2 (capacity ≠ identifiability).** $\text{rank}(J^T \mathcal{I} J) \leq \text{rank } \mathcal{I}$ is a necessary capacity condition, cleared with wide margin ($867 \geq 96$). The converse fails: a high-rank $\mathcal{I}$ does not determine J. The set of embeddings J with $J^T \mathcal{I} J = H$, for fixed rank-96 H inside a rank-867 form, is a positive-dimensional variety. Rank sufficiency removes an obstruction; it does not create identifiability. The actual differentiated embedding is still required.

# 23. Product marked outcome count

The $K = 7$ history law has 31 positive marked transitions, so the old seven-outcome neutral product had $31 \times 7 = 217$ factorised outcomes. The recurrent ten-outcome product has

$31 \times 10 = 310$ **(19)**

factorised outcomes on the same $7 \times 9 = 63$-state working history-record carrier. These 310 outcomes are the natural recurrent replacement for the one-shot 217-Kraus product. A literal Kraus list is not unique, but the marked physical instrument should be unique up to record-preserving phases, permutations and common-commutant basis transformations once its primitive path measure is fixed [11].

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# Part VII — Provenance status, falsifiers and the next theorem

## 24. What has been established

- A transparent conditional derivation of the 102-dimensional retained census.
- A clean separation of closure allowedness, Born conditional selection and TPB timing.
- A record-preserving renewal isometry that does not erase completed facts.
- A complete ten-outcome recurrent instrument at two regulator levels.
- A non-zero asymptotic neutral information return under finite-mean renewal.
- Removal in principle of the old rank obstruction to a rank-96 non-terminal pullback.
- A sharply reduced list of primitive objects still required for full provenance.

## 25. What remains unproved

| Required return | Concrete calculation | Why it matters |
|---|---|---|
| Primitive triangular attaching map | Enumerate every first-closing K = 7 history class $\mathcal{R}$_A and its persistent record label. | Fixes the physical outcome roster and allowed route support. |
| History-derived renewal operator | Compute the C→A reopening map from coarse-grained geometry and ledger persistence. | Eliminates arbitrary reset freedom. |
| Physical TPB waiting-time law | Return finite-mean hazards, cutoffs, and the proto-time/physical-time relation. | Fixes event timing and absolute clock normalisation. |
| Full 102-coordinate Jacobian | Differentiate every retained coordinate w.r.t. primitive marked history variables. | Makes $H = J^T \mathcal{J} J$ predictive, not manufacturable. |
| Complete cross-block Hessian | Compute all W_XY from one parent history functional. | Determines whether the FCHI direct sum survives. |
| Same-branch neutral physical boundary | Return Y_ν, M_D, M_R, thresholds and covariance on the admitted branch. | Connects structural renewal to physical neutrino observables. |

## 26. Named premises and falsifiers

| Premise | Statement | Falsifier |
|---|---|---|
| P1 | The imported K = 7 sector supplies the admissible triangular/Fano fact architecture. | F3 |
| P2 | The declared gauge/generation/species census is the correct retained-carrier decomposition (→ 102). | F3 |
| P3 | The supplied same-action polar maps U_D, U_R are the physical route-support maps. | F5 |

| Premise | Statement | Falsifier |
|---|---|---|
| P4 | The TPB stage hazards have finite mean ($\alpha > 1$ asymptotically, or a substrate cutoff). | F1 |
| P5 | Completed records admit an orthogonal persistent ledger (record-preserving dilation exists). | F2 |
| P6 | The programme Born kernel gives the conditional destination weights. | F4 |
| P7 | A history-derived Jacobian lands in a subspace of rank $\geq 96$. | F6 |

**Falsifiers.**

- **F1** — Every admissible substrate waiting law has infinite mean: the non-zero stationary fact rate fails.
- **F2** — Persistent records cannot coexist with reopening of the working carrier: the recurrent construction fails.
- **F3** — The primitive K = 7 attaching map excludes the neutral terminal classes or returns a different dimension: the 102 census is superseded.
- **F4** — The primitive path-correlation law returns normalised weights not equivalent to the programme Born kernel: (4)–(6) fail.
- **F5** — Higher regulator levels do not stabilise the support maps, stationary law or cross-block parent: the retained construction is not physical.
- **F6** — The history-derived Jacobian lands in a subspace of rank below 96: the FCHI parent cannot be recovered even though the ambient marked process has rank 867.

# 27. Corrected full-carrier provenance theorem target

**Target theorem (primitive K7 closure-to-renewal provenance).** Starting from one marked K = 7 history action, derive the terminal record-orbit decomposition, the first-closure attaching map, the finite-mean TPB compensators, the record-preserving renewal dilation, the same-action route support and strains, the complete 102-coordinate embedding, and every cross-block of the retained Hessian. Prove uniqueness only up to physical equivalence: gauge, exact nulls, common-commutant basis changes, and record-preserving phases or permutations.

If that theorem returns the present census and recurrent instrument, FCHI becomes a derived coarse-grained result. If it returns a different roster, reset map, hazard or cross-block parent, the primitive result supersedes FCHI. If several inequivalent classes remain, the substrate still contains constitutive freedom.

# 28. Conclusion

The proposed synthesis has survived its first direct construction test. K = 7 closure supplies a natural domain of fact-forming histories; the declared coarse-grained census explains the 102 retained dimensions; the programme Born rule supplies normalised conditional outcome weights; TPB supplies the correct logical home for event timing; and a persistent-ledger renewal step converts one-shot completion into an ongoing recurrent history without erasing facts.

Numerically, the construction is complete, positive and regulator-stable at the tested levels. It lifts the asymptotic neutral information rank from 0 to 21 and the $K = 7$ product rank from 72 to 867, so the previous long-history rank obstruction is not fundamental.

The central conclusion is nevertheless conditional. The paper constructs a viable recurrent full-carrier *equivalence class*; it does not uniquely derive that class from the unextended substrate. The remaining work is concentrated in four explicit maps: primitive loop-to-record attachment, history-derived record renewal, finite-mean TPB hazards, and the complete 102-coordinate defect-to-mark Jacobian with all cross-blocks.

**Final verdict.** $K = 7$ + closure + Born selection + TPB timing yields a viable recurrent full-carrier architecture and repairs the absorbing-history failure. The full primitive provenance theorem remains open.

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# Appendix A — Proof details

**A.1 Recurrent-instrument completeness.** The stage projectors satisfy $P_A + P_S + P_C = I_9$ and are mutually orthogonal, so $K_0^\dagger K_0 = (1 - p_D)P_A + (1 - p_R)P_S + (1 - p_B)P_C$. Because $U_D$ and $U_R$ are isometries on their three-dimensional source spaces, $\Sigma_i D_i^\dagger D_i = p_D P_A$ and $\Sigma_i R_i^\dagger R_i = p_R P_S$. The renewal maps have orthogonal source records, so $\Sigma_i B_i^\dagger B_i = p_B P_C$. Summing the four contributions gives $(1)P_A + (1)P_S + (1)P_C = I_9$. The orthogonal ledger marks make the outcomes distinguishable and preserve the completed facts. ■

**A.2 Stationary stage fractions for general renewal laws.** A complete fact cycle spends random durations $\tau_D$, $\tau_R$, $\tau_B$ in the active, singlet and completed working stages. For finite expectations, the renewal-reward theorem gives the fraction of long-run ticks in a stage as its expected duration over the expected cycle duration — equation (15). One completed record is produced per cycle, giving equation (14). ■

**A.3 Why finite mean is necessary.** For a non-negative integer waiting time, $E[\tau] = \Sigma_{(n \geq 0)} \Pr(\tau > n)$. If $\Pr(\tau > n) \sim C n^{-\alpha}$, the sum converges precisely when $\alpha > 1$. For $\alpha \leq 1$ an untruncated renewal process has zero asymptotic event density even though individual events still occur; a physical cutoff or tail crossover is therefore load-bearing. ■

**A.4 Rank capacity versus identifiability.** $\mathrm{rank}(J^T \mathcal{J} J) \leq \mathrm{rank}\, \mathcal{J}$ gives a necessary capacity condition, and the recurrent rank 867 clears the required 96 with wide margin. The converse is false: a high-rank $\mathcal{J}$ does not determine $J$ — infinitely many embeddings map a high-dimensional positive form to the same rank-96 Hessian. Primitive provenance therefore requires the actual differentiated embedding, not a factorisation reverse-engineered from a known target. ■

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# Appendix B — Numerical certificate

| Certificate field | Return |
|---|---|
| Designation | K7-CBR-1 |
| Claim grade | conditional structural construction + numerical stress test; primitive provenance not closed |
| Dimension census total | 102 |
| History positive marks | 31 |
| Renewal neutral outcomes | 10 |
| K7 × renewal product outcomes | 310 |
| Working carrier dimension | 63 |
| Level-3 completeness residual | $1.1102230246251565 \times 10^{-15}$ |
| Level-4 completeness residual | $9.992007221626408\,9 \times 10^{-16}$ |
| Level-3 spectral gap | $1.0312359911557323 \times 10^{-6}$ |
| Level-4 spectral gap | $1.0273778680014445 \times 10^{-6}$ |
| Mean record cycle (benchmark) | $3e/(e - 1) = 4.745930120608$ proto-ticks |
| Completed-record rate (benchmark) | $(e - 1)/3e = 0.210706852943$ per proto-tick |
| Neutral recurrent Fisher rank | 21 |
| K7 × recurrent Fisher rank | 867 |
| Package verdict | PARTIAL SUCCESS: renewal + Born-factorisation architecture constructed; unconditional full-carrier provenance remains open |

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# Appendix C — Reproducibility package

- `run_k7_cbr1.py` — complete numerical reconstruction and stress-test script.
- `results/K7_CBR1_calculation_certificate.json` — machine-readable principal certificate.
- `tables/dimension_census.csv` — typed derivation of the 102-dimensional carrier count.

- `tables/level_3_neutral_mark_probabilities.csv` — state-by-state recurrent benchmark mark probabilities.
- `tables/truncated_scale_free_TPB_rates.csv` — finite-cutoff audit of scale-free renewal tails.
- `arrays/level_3_renewal_neutral_kraus_10x9x9.npy` — level-3 ten-outcome recurrent Kraus instrument.
- `arrays/level_3_K7_x_renewal_population_kernel_63x63.npy` — level-3 K = 7 × recurrent population kernel.
- `sha256_manifest.json` — package integrity manifest.

The package is the K7-CBR-1 execution record; the present paper is its formal write-up and source-boundary statement.

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# References

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