Completed Event Weighting and Force Response in VERSF

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General reader summary

VERSF aims to explain the Standard Model's particles and forces from its underlying rules. This paper calculates how particle charges affect completed events, permanent records and the field response seen at larger scales. Grouping unchanged steps into an event preserves their combined response. Keeping only recorded crossings changes the available information in a calculable pattern. The paper also follows how records affect later motion and which configurations become records.

A separate quadratic approximation follows the field, current and active record together, including the particles' contribution. It gives responses for the colour, weak and hypercharge fields that survive grouping space into seven-cell blocks. Their changes with distance are close to the expected particle contribution. The earlier participation correction and full record feedback have not yet been derived within this same physical model.

The measured comparison exposes two problems. With its own starting strength and the provisional conversion tested here, electromagnetism is roughly half as strong as measured. Using the measured strong and electromagnetic strengths predicts a weak-mixing value about 1.7 per cent low. Exact doubling of the starting strengths makes electromagnetism about 4 per cent too strong and leaves weak mixing about 1 per cent low.

A further conditional test applies the earlier participation pattern to this comparison. The full-history correction takes weak mixing from below the measured value to above it, so it has the right sign and sufficient size. At gauge-only two-loop order, agreement requires roughly 60 per cent of that correction, whose physical value must be derived independently of measurement. Even there, the unfitted electromagnetic strength remains about half the measured value. The calculation therefore supplies a definite target for improving the force relationship while leaving the overall strength to be explained.

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Abstract

Event completion preserves the inherited charge response in VERSF when elapsed duration and the complete boundary carrier are retained. Omitting waits preserves the tested D41 participation family but changes its diagonal screening parameter from 0.084313 to 0.158932; relaxing the bath after observation gives 0.180902. The native birth–current–record operation is evaluated with its returned state and all 72 gauge derivatives. Its complete conditional channel is pressure silent in the specified scalar transfer. With fact-momentum energy attached to current intensity, minimum-pinned recording suppresses activity by about one fifth, whereas equilibrium-drawn and event-selected records leave it nearly unchanged. The event law determines a rate-biased configuration distribution within that parent. Differentiating the complete first-record functional, including preparation and waiting probabilities, gives a gauge-Hessian trace $(-6.184 \pm 1.564) \times 10^{-6}$; this is not a force coefficient.

A separate quadratic model gives conditional sector responses under stated unit, kinetic and temporal premises. One-block inverse couplings change by less than 0.005 per cent; spatial and temporal logarithmic coefficients are 0.995 and 0.992 against 1. Fixed normalisation gives electromagnetic inverse couplings 249.88 and 250.79 against 127.95 under zero finite conversion. Fitting the common factor and scale to strong and electromagnetic inputs predicts weak mixing 0.22729 and 0.22723 against the withheld 0.23122. Exact doubling overpredicts electromagnetic strength by 4.15 and 3.77 per cent. Separate conditional participation controls bracket the weak benchmark. At gauge-only two-loop order, $\varepsilon \approx 0.0487$ matches it, while fixed-normalisation electromagnetic inverse coupling remains 240.19. This target uses the weak measurement and is not a prediction. The participation response has not been derived on the same carrier as the quadratic model. Its physical selection, complete record feedback, common normalisation and observable conversion remain unresolved.

1 Question and result

The force-strength part of VERSF's Standard Model derivation needs the response of the complete physical history law to a gauge perturbation. This paper contributes explicit transformations from primitive histories to completed events and retained records, together with an executed birth–current–record operation. These calculations determine which inherited responses survive, which change, and how those changes enter the archived gauge map without fitting measured force strengths. The preceding source-history paper executes a joint phase-model transfer calculation and retains derivatives needed for that response [1]. The marked-instrument programme separately studies completed covers that visit all seven addresses and return to the initial address [2, Sections 83–87]. The executed ordered-ledger construction also specifies which individual transitions produce a record [5, Section 1D]. A complete cover and a single ledger-producing event are different stopping rules. Converting between these descriptions must preserve the elapsed primitive duration and the source dependence of the paths, not merely their final values.

This paper asks whether event completion supplies an additional response factor, and which retained record preserves the response. Exact grouping preserves the primitive pressure when duration and the complete boundary carrier are retained. The participation-dependent execution in Section 8 tests this directly on D41 and its archived gauge-to-current chart. The result is preservation, including for a rule that counts only marks at recorded crossings. A physical completion operation that changes subsequent dynamics is a different construction and must be included in the transfer itself.

The recording tests are equally specific. Section 4 evaluates the executed ledger for twelve address-rate changes. Section 8 proves that omitting waits preserves the D41 participation form while changing its coefficients, evaluates the additional bath relaxation after observation, and distinguishes incoming participation from a recorded quantum type. Section 9 evaluates the raw Gaussian pressure sensitivities needed to connect weight changes to a physical gauge perturbation. Section 10 derives the joint current increment and tests an explicit attachment of the native recorder to a magnitude-bearing event rate. Its failure at zero current and the regular construction that follows are stated separately from source selection. Section 11 connects that construction to the inherited resolved-birth maps, proves preservation of the recorded probabilities, and tests the alternative recording order. Section 12 carries that connection through a complete finite event, its birth-path probability and its full gauge derivative, including circulating currents. Its contact term provides an explicit test against identifying probability curvature with source stiffness. Sections 12.5–12.6 return the native output state, its internal-energy pairing and a state-level regularity test. Section 13 evaluates repeated native recording and carries the fact-momentum record energy through current relaxation, a full current fluctuation integral and a raw event transfer. Exposure, realised-record and radius controls then separate conditional numerical effects from source-selected weighting. The scalar-current derivatives expose the origin of the gauge response, while the complete native channel is pressure silent in the tested transfer. Section 13.9 determines the event-selected configuration distribution within that parent and differentiates the next-record functional, including preparation probabilities. Section 14 executes a separate quadratic current–record model with a temporal fermion extension, total sector responses and index-seven coarse graining. It reports finite-scale couplings, a spatial–temporal matching test and transport to the measured benchmark used by SGRI-1. Sections 14.6–14.10 separate fixed-normalisation failure from the two-input weak-angle comparison, test an exact doubling and audit which changes can alter a physical normalisation. The branches remain distinct; the diagnostic fitted factor is not inserted into the physical source.

The return identity is an application of first-return and Perron theory. Its role is to close a conversion within VERSF. The source-specific calculations use the directed seven-address clock, the marked D41 score family, the archived quantum instrument and the stated Gaussian parent. These models are kept distinct wherever their joint physical identification has not been supplied.

The calculations below retain distinct source laws where their physical identification is unfinished. Sections 14.6–14.10 compare the quadratic model of Section 14 with measurement. They do not treat the earlier participation and record-feedback results as corrections already included in that model. Section 14.8 additionally combines the printed participation coefficients with the spatial fermion term as a conditional sensitivity test. That test does not identify their physical carriers. The overview states how each result is used.

Calculation scope and use in the force comparison

Calculation	Result established here	Use in the final comparison
Completed events Sections 2–7 and 8.4	Unchanged histories preserve their response when duration and the complete boundary state are retained.	Constrains event conversion; supplies no extra multiplier.
D41 participation Sections 8.1–8.5	Omitted waits and bath relaxation preserve the participation family while changing its coefficients.	Excluded from the principal quadratic boundaries; tested separately in the conditional comparisons of Section 14.8.
Birth and native recording Sections 10–12	Finite event effects, gauge derivatives and the returned internal state are calculated.	Their full evolving event dynamics are not embedded in Section 14.
Record feedback Section 13	The stated current-energy model gives energetic and event-selection responses.	A separate model; its numerical response is not added to the Section 14 couplings.
Quadratic response and matching Section 14	Joint field, current and polar-record response, the fermion magnitude contribution and blocking are evaluated.	Provides the boundary values used for running and matching; unit attachment and observable conversion remain explicit premises.

2 Source law and completed events

2.1 The inherited law

The history-measure construction starts from a transfer law generated by an operational diffusion and an upstream potential [3, Sections 12, 14 and 56A]. It distinguishes the full history score from a reduced observation and requires memory to be retained when a projection is not Markovian. Its physical weighting is not supplied by assigning an independently chosen quadratic response back to the upstream potential. This distinction is retained throughout the present calculation.

The clock used here is the archived directed D36 transition matrix, with stationary measure π. It has seven addresses, one hub and six rim addresses, and a directed rim bias $\alpha = 0.959001109719975$. It is not replaced by an unbiased wheel. The calculation inherits the exact matrix bytes and the native instrument's conditional path moments [4]. For a fixed starting address a, the event duration is

$$\tau_a = \inf\{n \geq 1 : X_n = a,\ \{X_0, \dots, X_n\} = \{0, \dots, 6\}\}. \quad (1)$$

The transient state is the pair consisting of the current address and the visited-address mask. Absorption occurs on the first return to a after the mask is complete. This gives 255 transient states at the hub and 204 at a rim address. If A_a is the transient transition matrix, its mean-duration vector is $(I - A_a)^{-1}\mathbf{1}$. The initial-state entry gives the means in Table 1.

Table 1. Completed-cover clock. The last row averages the starting address with the inherited stationary measure.

Starting address	Mean primitive-step duration
Hub	20.61887152
Any rim address	21.43164073
Stationary mixture	21.27768295

The probability of the minimum length, seven primitive steps, is 0.00669406060 in the stationary mixture, reproducing the source value. Subsequent completed covers at a fixed anchor return to that anchor; the calculation does not resample it independently after each event. The sources use different clock grains: [2] counts primitive history transitions, whereas [5, Section 1D] reserves Fold for a committed fact and calls the underlying transitions renewal opportunities. This paper counts primitive steps explicitly. Neither the count nor grouping it into covers establishes a laboratory time conversion.

2.2 What is retained at an event boundary

The address alone need not specify the joint source. The boundary carrier must also retain the fields, currents, records, completion variables and matter variables required by its transition law, or an exact memory representation for variables that have been removed. The following theorem concerns a supplied joint transfer on such a carrier. It does not replace that transfer by the seven-address clock.

The Gaussian execution in Section 5 makes an additional product assumption: the D36 clock is independent of the inherited Gaussian phase evolution. The theorem in Section 3 does not require this assumption, and Section 7 verifies it with explicit coupling between the clock and an internal memory variable.

3 Exact conversion of the response

3.1 The return operator

Let $T_{\boldsymbol{\theta}}$ be a smooth finite nonnegative primitive transfer matrix on the complete retained carrier, with a fixed support near $\boldsymbol{\theta} = 0$. Let $\lambda_{\boldsymbol{\theta}}$ denote its Perron root. Define the relative primitive pressure by

$$p(\boldsymbol{\theta}) = \log \frac{\lambda_{\boldsymbol{\theta}}}{\lambda_0}. \quad (2)$$

Let Ω_a be the complete-cover paths returning to anchor a. They induce an operator on the boundary carrier. With s conjugate to primitive duration, it is

$$\mathcal{R}(s, \boldsymbol{\theta}) = \sum_{\omega \in \Omega_a} e^{-s\tau(\omega)} \lambda_0^{-\tau(\omega)} \prod_{e \in \omega} T_{\boldsymbol{\theta}}(e). \quad (3)$$

The sum retains the initial and final boundary indices. It includes every completed path allowed by the supplied law, without selecting an outcome. In the augmented transient carrier, let A denote transitions that have not completed the event and B the transitions that complete it. The path sum is obtained from

$$X = (I - A)^{-1} B, \qquad \mathcal{R} = P_{\text{in}} X, \quad (4)$$

where P_{in} selects the initial visited-mask rows. Both A and B include the duration factor and the source perturbation. The construction is finite even though it sums histories of arbitrary length.

Proposition 1 (completed-event pressure identity). Suppose the primitive transfer has finite irreducible support, fixed in a neighbourhood of the reference source, and completion visits the seven addresses and returns to the anchor. Then the return has the exponential moments required locally, and

$$\rho\big(\mathcal{R}(p(\boldsymbol{\theta}),\boldsymbol{\theta})\big) = 1. \quad (5)$$

Proof. Let $r_{\boldsymbol{\theta}} > 0$ be the right Perron vector. The transformed transition matrix has entries $T_{\boldsymbol{\theta}}(i,j)r_{\boldsymbol{\theta}}(j)/\big(\lambda_{\boldsymbol{\theta}} r_{\boldsymbol{\theta}}(i)\big)$. Its product along a path telescopes. At $s = p(\boldsymbol{\theta})$, the return operator is therefore similar, on the boundary carrier, to the stopped transition matrix of this transformed chain. Finite irreducibility makes the transformed chain recurrent. From each state there is a bounded-length path of positive probability that completes the cover and returns; the finite support supplies a uniform positive success probability in a neighbourhood of the source. This gives an exponential tail. The stopped transition matrix is stochastic, so its Perron root is one. No factorisation between clock and internal carrier was used.

The theorem preserves pressure per original primitive step. The curvature of $\rho\big(\mathcal{R}(0,\boldsymbol{\theta})\big)$ without the duration variable is a different object. Nor does the theorem apply unchanged if event completion physically resets a variable, selects an outcome, or changes the dynamics. Those operations must enter $T_{\boldsymbol{\theta}}$ or the boundary map explicitly.

3.2 Derivatives retained for the gauge calculation

Write $r(s,\boldsymbol{\theta}) = \rho\big(\mathcal{R}(s,\boldsymbol{\theta})\big)$. Differentiation of $r(p(\boldsymbol{\theta}),\boldsymbol{\theta}) = 1$ gives, at the reference point,

$$p_i = -\frac{r_i}{r_s}, \qquad p_{ij} = -\frac{r_{ij}+r_{is}p_j+r_{js}p_i+r_{ss}p_ip_j}{r_s}. \quad (6)$$

Indices i, j label source parameters. Here the derivatives are of the Perron root, including the variation of its eigenvectors. At the stationary return boundary, r_s is minus the mean duration. When the first source derivatives vanish, the second formula reduces to division of the event curvature by that mean. The mixed terms are required in the general case.

The operator derivatives can be evaluated without differencing complete path sums. For any source or duration coordinate u, differentiation of equation (4) gives

$$X_u = (I - A)^{-1}(A_u X + B_u), \quad (7)$$

$$X_{uv} = (I - A)^{-1}(A_{uv}X + A_u X_v + A_v X_u + B_{uv}). \quad (8)$$

A physical gauge calculation can use these identities once its complete $T_{\boldsymbol{\theta}}$ and gauge-entry derivatives are supplied. The identities do not select those derivatives. A positive reference transfer and a chosen observable pressure also require their stated relation to the physical action; the sign and normalisation of a gauge coefficient are not inferred from the word “pressure”.

4 What the terminal label and ordered ledger retain

4.1 The exact information decomposition

For a normalised path family $P_{\boldsymbol{\eta}}(\omega)$, let $S(\omega)$ be the score at the reference source. If Y is an observation obtained from the path through a parameter-independent recording rule, its score is the conditional mean of the path score. Consequently,

$$S_Y = \mathbb{E}[S \mid Y], \qquad I_{\text{path}} - I_Y = \mathbb{E}[\operatorname{Cov}(S \mid Y)] \succcurlyeq 0. \quad (9)$$

Proposition 2 (local record sufficiency). A retained observation preserves the path Fisher matrix if and only if the path score is determined by that observation almost surely, apart from null directions. Equation (9) is the test. It concerns the specified parameter family; preservation for one family need not imply preservation for physical gauge perturbations.

4.2 Native completed-event readout

The native archive supplies twelve centred address-rate scores $S_{xy,i}$, with $\sum_y T_{xy}\, S_{xy,i} = 0$, and their conditional first and second path moments for the terminal categories E, N, L, H, D, U and Q [4]. The initial preparation and the marked instrument are fixed. The twelve parameters are perturbations of scalar history probabilities, not the twelve gauge generators. The terminal category is a coarse readout, not the complete permanent ledger.

The calculation evaluates the full-path information and the information in the final category directly from those inherited conditional moments. Independently, it differentiates the transient complete-cover propagation to obtain the duration probabilities and their twelve derivatives, including the observed starting address. The initial stationary mixture is held fixed while differentiating. For the category probability p_f, conditional score mean m_f and path second moment M_f, the matrices are

$$I_{\mathrm{path}} = \sum_f p_f\, M_f, \qquad I_{\mathrm{label}} = \sum_f p_f\, m_f m_f^{\mathrm{T}}. \quad (10)$$

Generalised eigenvalues of $I_Y v = \gamma I_{\mathrm{path}} v$ measure the retained fraction in each parameter direction. Table 2 reports their maximum, not an average. The duration calculation propagates to 600 primitive steps and checks the omitted probability and tangent tails.

Table 2. Information retained for the twelve native rate directions. The two reduced observations are evaluated separately.

Observation	Largest retained fraction	Numerical rank
Complete path score	1	12
Final seven-category label	0.0000136607	6
Duration and starting address	0.2591130	11

The label retains at most 13.66 parts per million of the tested path information. Its rank is bounded by six because there are seven probabilities summing to one. Duration and starting address retain at most 25.91 per cent. Their information must not be added to the category information: their joint distribution and correlations would have to be evaluated first. The small label result does not contradict a permanent record that contains additional variables.

The calculation also verifies $I_{\mathrm{path}} = \bar{\tau} I_{\mathrm{step}}$ and equation (9). These statements use the martingale-difference property of the centred transition scores, not an assumption that successive marked outcomes are independent.

4.3 The source ordered ledger

The executed record alphabet is (e, r): an undirected edge and a terminal type. Every nonself transition contributes an entry; self-history transitions contribute none and act as the identity on the internal carrier [5, Section 1D]. The microscopic current-channel label is not recorded. These are inherited properties of the executed architecture, whose derivation and permanent absorption are separately conditional in that source. The present calculation holds the preparation and instrument fixed, as in Section 4.2.

Let $s_x = T(x,x)$ and let S_{xx} be the corresponding twelve-component score. Summing every possible number of self transitions before the next crossing gives the recorded-jump kernel and its score, for $y \neq x$:

$$T^{\mathrm{rec}}_{xy} = \frac{T_{xy}}{1-s_x}, \qquad j_{xy} = S_{xy} + \frac{s_x}{1-s_x} S_{xx}, \qquad T^{\mathrm{rec}}_{xx} = 0. \quad (11)$$

This is the address part of the source's first-record effect, evaluated without an extra hazard or weighting. For the finite parameter family of Section 6.1, the exact law is $T^{\mathrm{rec}}_{\eta,xy} = T_{xy} e^{\eta^{\mathrm{T}} S_{xy}} / \sum_{z \neq x} T_{xz}\, e^{\eta^{\mathrm{T}} S_{xz}}$. Thus the ordered ledger has an explicitly calculated likelihood, not merely a bound on its information.

Proposition 3 (ordered ledger and waiting decomposition). In this executed architecture, the complete ordered edge word of a seven-address cover determines the oriented jump path. For the fixed instrument and twelve address-rate parameters, let I_{ledger} denote its Fisher matrix and μ the mean number of original steps. Then

$$I_{\mathrm{ledger}} = \mu \sum_x \pi_x \sum_{y \neq x} T_{xy}\, j_{xy} j_{xy}^{\mathrm{T}}, \quad (12)$$

$$I_{\mathrm{path}} - I_{\mathrm{ledger}} = \mu \sum_x \pi_x \frac{s_x}{1-s_x} S_{xx} S_{xx}^{\mathrm{T}}. \quad (13)$$

A parameter direction v is fully retained if and only if $S_{xx}^{\mathrm{T}} v = 0$ for every address with $\pi_x s_x > 0$.

Proof. Two consecutive distinct undirected edges determine their common vertex, hence their traversal directions; the rest of the ordered path is reconstructed forwards and backwards. A completed cover necessarily contains such a pair. Given the jump path, the omitted self counts are independent with probabilities $(1-s_x)s_x^h$, $h \geq 0$. Their centred scores are $\big(h - s_x/(1-s_x)\big)S_{xx}$ and their conditional covariance is $s_x S_{xx} S_{xx}^{\mathrm{T}}/(1-s_x)^2$. Expected original departures in a closed stopped path are $\mu\pi_x$: occupation balance gives an invariant measure, whose total mass is μ. Expected jump departures are consequently $\mu\pi_x(1-s_x)$. Summing the conditional waiting covariances proves the second identity; row-centred jump scores prove the first. Recorded types have parameter-independent conditional probabilities given the jump path, because the instrument is fixed and self transitions leave its internal state unchanged. They add no score for this family. Positivity of every summand gives the final equivalence.

The spectrum in Table 3 is independent of the anchor because both information matrices scale with the same mean duration μ_a. The loss is a sum of seven rank-one matrices, hence at least five of the twelve directions must be lossless. Here its rank is exactly seven. The seven-by-seven whitened self-score Gram is invariant under rim rotations and reflections: its two trivial modes are fully lost, while the alternating mode and the two two-dimensional rim Fourier modes give the partial multiplicities $1 + 2 + 2$. This is a symmetry of the information Gram, not a claim that the directed clock is reflection invariant. Zero eigenvalues are reported as zero within floating-point precision.

Table 3. Information retained by the complete ordered ledger for the native rate family.

Generalised information fraction	Multiplicity	Interpretation
0	2	Only waiting probabilities change
0.416826	1	Partial retention
0.595639	2	Partial retention
0.750797	2	Partial retention
1	5	Full local retention

The ledger therefore has information rank ten, while the full path has rank twelve. The complete-cover mean is 21.277683 original steps and 17.247185 recorded crossings. It is not a single ledger entry. These results are neither the final-label fractions of Table 2 nor physical force reductions. In particular, information about time spent waiting is not restored merely by knowing the order of the recorded changes. Adding waiting counts would restore the full path score, but their retention is not part of the implemented alphabet used here.

For a parameter-entry map $\eta = B_g\theta$, the loss is the pullback of the positive matrix in the second identity. It vanishes exactly when $S_{xx}^{\mathrm{T}}B_g = 0$ for every occupied address. This gives a computable preservation criterion for a gauge map if that map lies in the tested rate family with fixed instrument. A physical perturbation that also changes field evolution or Kraus operations requires their additional scores; the twelve scalar directions cannot substitute for them.

5 The joint Gaussian field and record calculation

5.1 Inherited parent and scope

The inherited phase model has 140 real coordinates, a positive quadratic parent H and a coarse map Q retaining four real coordinates for two spatial hypercharge polarisations [1, Section 19]. It uses flat diffusion, a supplied phase-parent potential and static fermion curvature. Radial matter is absent and completion is decoupled on this branch. Its H has not been established as the full upstream potential of the history-measure construction. The present calculation retains these assumptions rather than treating the model as the complete physical source.

For a dimensionless numerical step h, diagonalise $H = U\mathrm{diag}(\lambda_j)U^{\mathrm{T}}$. The exact Gaussian transfer yields mode drift f_j and stationary variance s_j:

$$R_j = \sqrt{\lambda_j + h^2\lambda_j^2/4}, \qquad f_j = \left(1 + hR_j + h^2\lambda_j/2\right)^{-1}, \qquad s_j = \left(2R_j\right)^{-1}. \quad (14)$$

Let $F = U\mathrm{diag}(f_j)U^{\mathrm{T}}$ and $\Sigma = U\mathrm{diag}(s_j)U^{\mathrm{T}}$. The retained static stiffness is

$$K = \left(QH^{-1}Q^{\mathrm{T}}\right)^{-1}. \quad (15)$$

This is the model's relaxed field response. Its matter-induced change is not a measured force-strength prediction.

5.2 Full event reward and final field sampling

For a fixed anchor, put $\mu = \mathbb{E}\tau$ and $g_j = \mathbb{E}\left[f_j^{\tau}\right]$. Retaining the event reward $R_k = \sum_{t\in k} Q\, z_t$ includes all intermediate field values. Its covariance separates into the within-event term C_{in} and the sum C_{cross} of covariances between distinct events, including both time orders:

$$C_{\mathrm{in}} = QU\mathrm{diag}\left[s_j\left\{\mu\frac{1+f_j}{1-f_j} - \frac{2f_j(1-g_j)}{(1-f_j)^2}\right\}\right]U^{\mathrm{T}}Q^{\mathrm{T}}, \quad (16)$$

$$C_{\mathrm{cross}} = QU\mathrm{diag}\left[\frac{2s_jf_j(1-g_j)}{(1-f_j)^2}\right]U^{\mathrm{T}}Q^{\mathrm{T}}. \quad (17)$$

Adding them gives the completed-event response per unit original numerical time:

$$\frac{h}{\mu}(C_{\mathrm{in}} + C_{\mathrm{cross}}) = QH^{-1}Q^{\mathrm{T}} = K^{-1}. \quad (18)$$

The cancellation is exact on this Gaussian product branch. In contrast, sampling only the final field of each event gives the integrated covariance per event index

$$C_{\mathrm{end}} = QU\mathrm{diag}\left[s_j \frac{1+g_j}{1-g_j}\right] U^{\mathrm{T}} Q^{\mathrm{T}}. \quad (19)$$

Multiplying this final-field covariance by the mean duration does not reconstruct equation (18). At $h = 1$, that replacement overestimates the covariance by factors between 15.98 and 16.66 for the hub and rim cases. Even though adjacent final fields are almost uncorrelated, their values do not encode the accumulated field response between events.

Table 4. Hypercharge stiffness ratios with static fermion curvature divided by the bosonic reference, at unit numerical step. The duplicated eigenvalues arise from realification.

Calculation	Smallest ratio	Largest ratio
Complete event, per original time	0.99316642	0.99317137
Inverse final-field covariance, hub anchor	0.99451910	0.99453417

The first row preserves the inherited approximately 0.68 per cent reduction. The second is a different observation-based quantity, with an approximately 0.55 per cent reduction; it is not an alternative physical prediction. Equation (18) explains why event grouping cannot supply additional D41 screening by a clock conversion alone.

5.3 Information about a shared mean shift

To test what a final field reading can recover, specify the parameter entry explicitly. Let $E = H^{-1}Q^{\mathrm{T}}K$, so $QE = I$, and consider

$$z_{t+1} = Fz_t + (I - F)E\boldsymbol{\theta} + \xi_t, \qquad \mathrm{Cov}(\xi_t) = hF. \quad (20)$$

The complete initial fine state is conditioned on and its distribution held fixed. This is a mean-shift family of the inherited parent, not a derivation of the physical gauge-entry map. The full-path information per step is hK. Conditional on a known duration n, the final coarse field has derivative $A_n = Q(I - F^n)E$ and covariance $V_n = Q\left(\Sigma - F^n\Sigma(F^n)^{\mathrm{T}}\right)Q^{\mathrm{T}}$. Therefore

$$I_{\mathrm{final}} = \sum_n P(\tau = n) A_n^{\mathrm{T}} V_n^{-1} A_n, \qquad I_{\mathrm{path}} = \mu hK. \quad (21)$$

Table 5. Range of retained information across the four mean-shift directions, with duration known. These step sizes are numerical controls, not selected physical clocks.

Numerical step	Hub anchor	Rim anchor
1	6.24–6.26%	6.00–6.02%
1/4	14.00–14.19%	13.47–13.65%
1/16	41.94–42.77%	40.64–41.45%

The increase at smaller step reflects less relaxation during a completed cover. It does not establish a continuum physical limit. The full event response remains equation (18) in every row; the reduced observation changes with the sampling interval.

6 Compact sufficient records

6.1 An exact record for the native rate family

The loss in Table 2 does not imply that a permanent record must store the complete chronological path. Consider the row-normalised exponential family defined by the inherited rate directions,

$$T_{\boldsymbol{\eta}}(x,y)=\frac{T(x,y)e^{\boldsymbol{\eta}^{\mathrm{T}}S_{xy}}}{Z_x(\boldsymbol{\eta})},\qquad Z_x(\boldsymbol{\eta})=\sum_y T\,(x,y)e^{\boldsymbol{\eta}^{\mathrm{T}}S_{xy}}. \quad (22)$$

For a completed path, retain its twelve accumulated scores $S_\omega=\sum_{e\in\omega}S_e$ and seven departure counts N_x. The complete likelihood ratio is

$$\log\frac{P_{\boldsymbol{\eta}}(\omega)}{P_0(\omega)}=\boldsymbol{\eta}^{\mathrm{T}}S_\omega-\sum_x N_x\log Z_x(\boldsymbol{\eta}). \quad (23)$$

Proposition 4 (sufficient accumulated rate record). With the preparation and marked instrument fixed, $(S_\omega,N_0,\dots,N_6)$ is sufficient for the family (22) on completed paths. The accumulated score alone preserves the local Fisher matrix at the reference source.

Proof. Every transition contributes its numerator tilt and its departure-row normalisation. Multiplying them gives equation (23). The marked-instrument factor has no parameter dependence under the stated premise and cancels in the likelihood ratio. The stopping rule is a deterministic path condition with unchanged support. Since each S_{xy} is row centred, the derivative of $\log Z_x$ vanishes at zero; the path score is precisely S_ω. The factorisation and Proposition 2 establish the claims.

This is a sufficient record, not a claim of globally minimal storage. The implemented ordered ledger has been tested in Section 4.3 and does not retain the complete statistic: omitted self counts produce exactly the stated loss. A parameter-dependent instrument would add its own score and normalisation terms.

6.2 An exact record for the Gaussian mean family

For equation (20), put $D=(I-F)E$ and define the accumulated innovation score at the reference mean by

$$S_\omega=\sum_{t=0}^{n-1}D^{\mathrm{T}}\,(hF)^{-1}(z_{t+1}-Fz_t). \quad (24)$$

Its likelihood factorisation is

$$\log\frac{P_{\boldsymbol{\theta}}(\omega|z_0,n)}{P_0(\omega|z_0,n)}=\boldsymbol{\theta}^{\mathrm{T}}S_\omega-\frac{nh}{2}\boldsymbol{\theta}^{\mathrm{T}}K\boldsymbol{\theta}. \quad (25)$$

Proposition 5 (sufficient Gaussian event record). Conditional on the initial fine state, the four-component S_ω and duration n preserve the full likelihood dependence on the specified mean shift. With the independent clock used in Section 5, they preserve all the information μhK.

Proof. Expanding the conditional Gaussian transition densities gives equation (25), using $D^{\mathrm{T}}(hF)^{-1}D=hK$. The independent duration law contributes no parameter derivative. Thus the score and duration suffice without retaining each intermediate field value.

Direct path-density evaluations verify equation (23) on 400 complete native histories and equation (25) on 120 Gaussian paths across both parents and all three step sizes. The maximum absolute log-likelihood discrepancies are 2.7×10^{-15} and 4.7×10^{-12} respectively. These checks compare finite parameter changes, rather than only infinitesimal Fisher matrices.

The operational requirement emerging from these constructions is precise: a proposed physical recording map must preserve the score of the physical perturbation, or retain variables from which it can

be recovered. The constructed records demonstrate possibility for the two tested families. Section 4.3 evaluates the implemented native ledger, while identification of the complete physical recording map remains a source obligation.

7 Verification with an interacting clock

The pressure theorem is tested independently on seven addresses coupled to a two-state memory, giving fourteen states. If the memory is $b \in \{0,1\}$, the next-address law is proportional to $T(x,y)\exp[\kappa(2b-1)\cos(2\pi y/7)]$. The memory flip probability is $0.18 + 0.09[1 + \sin(2\pi(x+y)/7)]$. Thus the address and memory dynamics are coupled for nonzero κ.

The source tilts each transition by a centred destination observable, $(2b-1) + 0.35\cos(2\pi x/7)$ minus its stationary mean. The primitive pressure curvature is calculated from the fourteen-state operator. Independently, the event operator is calculated on 510 augmented transient states at the hub and 408 at a rim anchor. The source and duration derivatives are retained through equation (8). The couplings κ are declared controls, not values derived from VERSF.

Table 6. Coupled-clock verification at the hub anchor. Curvatures refer to the single test observable.

Coupling	Primitive curvature	Event curvature per primitive step	Raw event curvature
0	2.79179952	2.79179952	57.56375554
0.3	3.01094622	3.01094622	62.57253452
0.6	3.18641054	3.18641054	67.72728692

The first two curvatures agree to below 4×10^{-15} at both anchors. Finite source changes and an independent finite-difference curvature check also pass. The raw event curvature differs because an event contains many primitive steps. This example verifies the return construction without clock independence; it does not promote the Gaussian product assumption to a physical source result.

8 D41 participation and completed events

8.1 The actual current scores include waiting

The archived D41 law has five participation marks $\chi_m = (111), (101), (011), (001), (000)$ with probabilities $(18,18,8,3,2)/49$, and two real fibres of probability one half. Its transition probability is $p_{xyfm} = T_{xy}p_m/2$. The thirty row-centred source scores comprise twelve old directions, six current directions and twelve bath directions. Profiling the bath gives six efficient current scores E_{xyfm} whose Gram is

$$W = \sum_{xyfm} \pi_x \, p_{xyfm} E_{xyfm} E_{xyfm}^{\mathrm{T}} = I_2 \otimes \left(dH - \Delta m m^{\mathrm{T}}\right). \quad (26)$$

Here $H = \mathbb{E}[\chi\chi^{\mathrm{T}}]$, $m = \mathbb{E}[\chi]$, $d = 0.0551296278772322$ and $\Delta = 0.004648154590676$, as in [1, Sections 11–13]. The original twelve directions are held fixed in this bath profile. The implementation reconstructs the full score Gram and the efficient columns from the archived arrays.

A bare cycle cochain is zero on a self-edge. Its row-normalised score subtracts the departure-row mean, which need not vanish. The archive's largest self-entry of the unprofiled current-score array has magnitude 0.186158; the largest efficient D41 self-score is 0.320932. It is therefore necessary to evaluate the waiting loss rather than set it to zero geometrically.

Let $a_x = \mathbb{E}[E_{xxfm} \mid x \to x]$ and $V_x = \mathrm{Cov}(E_{xxfm} \mid x \to x)$. When all self histories are omitted but the direction, fibre and mark of each crossing are retained, the score of the next recorded crossing is $J_{xyfm} = E_{xyfm} + s_x a_x/(1 - s_x)$. The per-primitive-step information satisfies

$$I_{\mathrm{cross}} = \sum_{x,y\neq x,f,m} \pi_x\, p_{xyfm} J_{xyfm} J_{xyfm}^{\mathrm{T}}, \qquad W - I_{\mathrm{cross}} = \sum_x \pi_x \left(s_x V_x + \frac{s_x}{1-s_x} a_x a_x^{\mathrm{T}} \right). \quad (27)$$

Proposition 6 (marked waiting loss). The second term in equation (27) is the complete loss from omitting the self histories in this marked-rate family. It is zero precisely when every occupied self-transition has zero efficient score almost surely.

Proof. Conditional on a crossing from x, the number of omitted holds is geometric with mean $s_x/(1 - s_x)$ and variance $s_x/(1 - s_x)^2$. Their marks and fibres are independently drawn from the stated self-transition law. The conditional score variance is the mean count times V_x, plus the count variance times $a_x a_x^{\mathrm{T}}$. Multiplication by the original-step crossing frequency $\pi_x(1 - s_x)$ gives equation (27). Both terms are positive semidefinite. Equivalently, expand the Gram of J and use the row-centred score identity. The calculation verifies this independently by differentiating the exact geometric first-crossing likelihood.

Table 7. Retained information for the six efficient D41 directions, with direction, fibre and participation mark retained at each crossing and all self histories omitted.

Generalised fraction	Multiplicity	Loss
0.837468	1	16.2532%
0.867344	1	13.2656%
0.924389	4	7.5611%

The waiting loss has rank six. In each of the two original current-profile blocks, the separate colour, weak and hypercharge diagonal information fractions are 0.870366, 0.886075 and 0.852406. Those diagonal fractions are not generalised eigenvalues because the sector columns are correlated. All six directions remain identifiable in this observation; incomplete information does not mean that the participation structure has disappeared. Omitting the real-fibre label reduces the generalised fractions further, to 0.130644, 0.130644, 0.136314, 0.700431, 0.793745 and 0.793745. The archive gives these additional observation controls.

These results concern the efficient subfamily specified above. Section 8.2 evaluates both its exact participation form and the further bath relaxation after observation. The observed alphabet here is richer than the native quantum ledger: it retains crossing direction, real-fibre label and participation mark. Identifying the two history laws is a separate physical statement.

8.2 Participation form and the order of bath relaxation

Table 7 contains a structural result, not merely six retained fractions. Let $u = 1,2$ label the two current coordinates and $A = C, W, Y$ the participation factors. This current-coordinate index is distinct from the random real-fibre label f in p_{xyfm}. On the exact arrays the efficient scores have the pointwise form $E_{uA} = c_u(\chi_A - m_A) + q_u m_A$. The coefficient is the row-normalised unmarked current score: if $s_u^{\mathrm{row}}(x, y)$ is the archived complex score, then $c_u(x, y, f) = \sqrt{2}\,\mathrm{Re}s_u^{\mathrm{row}}$ for $f = 1$ and $\sqrt{2}\,\mathrm{Im}s_u^{\mathrm{row}}$ for $f = 2$, each fibre having weight $1/2$. It is not the bare cycle cochain. The subsequent centring of the marked score and its bath projection affect q_u, while this already row-normalised coefficient remains. The archive verifies this identity at every address, transition, real fibre and mark.

Proposition 7 (participation form under omitted waits). Suppose the mark law is independent of the address and real fibre, and the efficient scores have the stated form. Omitting holds while retaining the crossing direction, real fibre and mark preserves the matrix family $I_\times = A \otimes H - B \otimes mm^{\mathrm{T}}$, where A and B are real symmetric matrices on the two current coordinates. On the supplied D41 law, $A = d'I_2$ and B has equal diagonal entries. Reprofiling the same twelve bath directions after observation preserves this family and leaves A unchanged.

Proof. The self-score mean has components $a_{x,uA} = \bar{q}_{x,u}m_A$. Summing the geometric number of omitted holds replaces q_u by $q'_u = q_u + s_x\bar{q}_{x,u}/(1 - s_x)$ and leaves c_u unchanged. Independence of the mark gives $\mathbb{E}[(\chi - m)(\chi - m)^{\mathrm{T}}] = H - mm^{\mathrm{T}}$ and removes its cross term with m. With the crossing weights per primitive step, put $A = \sum \pi_x p_{xyf} cc^{\mathrm{T}}$ and $Q = \sum \pi_x p_{xyf} q'q'^{\mathrm{T}}$, summing only $y \neq x$. Then $I_\times = A \otimes \left(H - mm^{\mathrm{T}}\right) + Q \otimes mm^{\mathrm{T}}$ and $B = A - Q$. The archived coefficients give $A = d'I_2$ and equal diagonals of B; these are additional checked source identities, not consequences of membership in the participation span alone. The bath scores are mark independent. Subtracting their observed regression changes q' but not c, so the reprofiled form has the same A.

Write $B = \begin{pmatrix} \Delta' & b_\times \\ b_\times & \Delta' \end{pmatrix}$. Table 8 gives the coefficients reconstructed from the scores, without fitting the three displayed sector fractions. The largest entrywise participation-form residual is below 10^{-15}. The off-diagonal current block is exactly $-b_\times mm^{\mathrm{T}}$; the two diagonal blocks coincide. Thus the bright-mode split is a cross-component coupling, not an asymmetry of their diagonal responses.

Table 8. Coefficients of the full six-direction participation form. All entries are per primitive step. The same centred coefficient applies to both crossing calculations.

History response	Centred coefficient	Mean diagonal	Mean cross block
Full history	0.055129628	0.004648155	0
Observed efficient scores	0.050961214	0.008099365	0.000789144
Bath reprofiled after observation	0.050961214	0.009218986	0.000987569

For the first crossing calculation, $d'/d = 0.924388859630$, $\Delta'/d = 0.146914928721$ and $\epsilon'_{\mathrm{diag}} = \Delta'/d' = 0.158931955086$. In the symmetric and antisymmetric current combinations the screening parameters are instead $(\Delta' \pm b_\times)/d'$, namely 0.174417151376 and 0.143446758796. Since $m = He_Y$, the bright participation factor is $m^{\mathrm{T}}H^{-1}m = 47/49$. The two bright generalised fractions are therefore $[d' - (\Delta' \pm b_\times)47/49]/[d - \Delta 47/49]$; the four remaining fractions are exactly d'/d. This derives all of Table 7 and identifies its multiplicity-four value. In particular, $d - d' = \sum_x \pi_x s_x \mathbb{E}_f[c_u(x, x, f)^2] = 0.004168414032$ for either u, with zero cross-current entry. Thus the four dark fractions are $1 - (d - d')/d = 0.924388859630$ directly from the omitted self scores. Their complex unscaled magnitude reaches 0.18615754; the real, $\sqrt{2}$-normalised coefficients used in the Gram reach 0.26321052.

Observation and bath relaxation do not commute. Let J_B denote the twelve observed bath scores, G_B their Gram, and $M_B = \langle J, J_B \rangle$ their cross Gram with the observed full-history efficient scores. Profiling after observation gives $I_{\times,\mathrm{prof}} = I_\times - M_B G_B^{-1} M_B^{\mathrm{T}}$. The full 30-score calculation has nonsingular G_B and a nonzero rank-two subtraction of Frobenius norm 0.002800200440. It returns $\epsilon'_{\mathrm{diag}} = 0.180902001085$, with principal values 0.161523166724 and 0.200280835446. Its bright retained fractions are 0.812517927195 and 0.849906427989; the four dark fractions are unchanged. The subtraction is positive semidefinite, so $I_{\times,\mathrm{prof}} \preccurlyeq I_\times$. The value 0.180902 parametrises the Cramér–Rao-efficient current information in the crossing-only experiment with its bath treated as a nuisance there. The value 0.158932 parametrises information along the full-history-efficient directions, with that nuisance compensation

fixed by the full dynamics. The physical fork is therefore full history without record loss (0.084313), observed full-history-efficient response (0.158932), or bath relaxation against the observations (0.180902). The numbers are screening parameters of these matrices, not themselves information eigenvalues.

Table 9 states the force-relevant consequence under a further, explicit premise: the gauge response uses the multiplicative attachment $Z_A(1-\epsilon n_A/49)$, with $Z=(6{,}13/2{,}21/2)$ and $n=(36{,}26{,}47)$. Each crossing row uses one original current component, or the equal incoherent average of those two components. It does not represent an arbitrary superposition, which sees the cross block in Table 8. The rows divide by their own centred coefficient; the common reduction d'/d must also be carried if a physical normalisation retains it.

Table 9. Conditional gauge coefficients under the specified multiplicative attachment and current-component reading. These are consequences of the premises, not selected physical force strengths.

Response used	Colour	Weak	Hypercharge
Full history	5.628334	6.209206	9.650846
Observed efficient scores	5.299402	5.951847	8.899328
Bath reprofiled after observation	5.202554	5.876073	8.678058

The diagonal participation reductions are respectively $(6.1944{,}4.4738{,}8.0872)\%$, $(11.6766{,}8.4331{,}15.2445)\%$ and $(13.2908{,}9.5989{,}17.3518)\%$. Their 36: 26: 47 pattern survives in each specified reading. The history and observation principles alone do not choose a row: retaining a record need not erase the dynamical effect of the unrecorded history. That choice requires the joint transfer and the physical observable it couples to. Sections 8.3 and 15.4 specify the distinction that the native operation must resolve.

8.3 Incoming participation and the recorded type

The native instrument records an outgoing central type after applying its current-dependent Kraus channel. It does not generally record the incoming type of the same transition. This can be tested without changing the native preparation. The rank-49 innovation state $\rho_0=(I-|\Omega\rangle\langle\Omega|)/49$ commutes with the five participation projections Π_m. Resolving that initial mixture gives the one-step joint probabilities

$$q_e(m,r)=\mathrm{Tr}\big[P_r\sum_\alpha C_{e\alpha}\,\Pi_m\rho_0\Pi_m C_{e\alpha}^\dagger\big]. \quad (28)$$

Their mark marginal is exactly p_m, and summing over m recovers the native one-step Born law. The outgoing type does not determine this incoming mark: the largest conditional variance of a participation indicator over the twelve edges is 0.089641. With edge and outgoing type retained, the uncentred participation Gram has generalised fractions 0.877466, 0.892964 and 0.997219 against H. These three numbers test this one-step preparation refinement, not the complete six-direction D41 ledger. For example, averaged over stationary crossings, an outgoing L type has incoming colour probability 0.045448 and incoming weak probability 0.973339; its own outgoing participation is exactly (0,1,1).

There is an essential history qualification. After an outcome r is recorded, the internal state is supported on P_r, so its participation before the next crossing is known from the previous record. Self transitions act as the identity. The ordered type history therefore carries information that a single outgoing label lacks. The classical D41 law independently samples its marks and real fibres at each step; the native quantum instrument evolves its internal state without that reset. Equation (28) provides a non-disturbing refinement of the initial preparation, not permission to reprepare it at every step. Consequently neither a lossless D41 ledger nor its exclusion follows from the single-step conditional-mark test alone.

8.4 Participation-dependent completion

Address-only stopping cannot change the sector ratios of a supplied common-carrier response. A stronger statement holds: changing to a participation-dependent stopping rule also preserves the primitive pressure if it merely partitions unchanged histories and retains the complete boundary state and duration.

Proposition 8 (stopping-rule invariance of sector response). Suppose an admissible finite-state stopping rule has an almost-surely finite duration with a local exponential tail, and every completed event retains its terminal boundary carrier without resetting or selecting it. Its duration-discounted event operator satisfies Proposition 1. Thus its pressure Hessian per primitive step is unchanged. In particular, if the primitive response factorises into a common spatial coefficient and the representation coefficients (6,13/2,21/2), completion alone preserves their ratios. A different ratio requires a change of source dynamics, a physical boundary operation, or a different observable, rather than a new partition of the same paths.

Proof. The Perron eigenvector ratio telescopes for any stopped path, regardless of whether stopping depends on addresses, participation marks or internal variables. At the primitive pressure the transformed stopped operator is stochastic on its retained boundary carrier. Its spectral radius is one. Differentiate this identity as in Section 3.2. For a finite accessible mark-mask construction, the positive probability of visiting every required mark in a bounded number of steps supplies the exponential tail.

This is executed for first occurrence of all five D41 marks. The augmented state is an address and one of 31 incomplete five-bit masks, giving 217 transient states and seven terminal address states. A second rule counts marks only on nonself crossings. Each event retains its final address; the mask is cleared for the next event. The raw exponential generating transfer $p_{xyfm}\exp\left(c^{\mathrm{T}}E_{xyfm}\right)$ tests the cumulants of the efficient score. It is not identified with the complete physical action transfer. For the row-normalised probability law itself the Perron root is one identically; the nonzero information must not be obtained by differentiating its total probability.

Table 10. Participation completion, with the full marked path and terminal address retained. Ratios compare the completed-event pressure Hessian per original step with W.

Completion rule	Mean duration	Six response ratios
All marks on primitive transitions	31.655972	All 1, within 8×10^{-15}
All marks on recorded crossings	39.053662	All 1, within 6×10^{-15}

The first mean has the exact coupon-collector expression $\bar{\tau} = \sum_{\varnothing \neq S \subseteq \{1,\ldots,5\}} (-1)^{|S|+1} / p(S)$, where $p(S) = \sum_{m \in S} p_m$. It is independent of the starting address because the five marks are sampled independently at each primitive step. For the crossing rule, the stationary event-boundary law is $\nu_x = \pi_x(1 - T_{xx})/\bar{h}_{\mathrm{cross}}$: its hub weight is 0.200305886207 and each rim weight is 0.133282352299. Averaging the conditional durations with this law gives $\bar{\tau}/\bar{h}_{\mathrm{cross}} = 39.053662326603$; using π instead gives 39.054392. This event-chain boundary law, rather than a new preparation at each event, is used in Table 10.

The second rule has nonzero source–duration coupling. Its first source derivatives nevertheless vanish at the centred reference because the transition scores are row centred, so the mixed terms in equation (6) give no additional quadratic response; address independence of the first rule's duration alone would not prove this derivative statement. The computed Hessian differs from W by less than 4×10^{-17} entrywise.

Finite source tilts independently satisfy the stopped Perron identity. This closes the mark-completion test for the archived rate family; it does not simulate quantum completion on all seven outgoing types.

8.5 Pullback through the archived gauge map

The source-history archive supplies a 36-column efficient current-score map U_{eff} on the scalar parent [1, Section 11] and a separate static gauge-to-current chart. The following test uses the latter's six-direction D41 coordinates. Put $B_g = L_{\mathrm{native}} A_g$, where the gauge-to-cycle-current Jacobian A_g has size 600×72 and the archived dual map L_{native} has size 6×600. The corresponding response is

$$G_{\mathrm{chart}} = B_g^{\mathrm{T}} W B_g. \quad (29)$$

The calculation reconstructs the nonlinear link perturbation, projects its induced current onto the six cycle modes and applies the archived dual map. Centred finite differences verify B_g. Both stopping rules in Table 10 give exactly the same pulled-back response; four independent gauge probes agree to the stated numerical tolerance. This is a check of Proposition 8, not an independent preservation result. The nonzero mixed derivative 0.368980 belongs to the crossing-completion rule, but its contribution in equation (6) is multiplied by vanishing first source derivatives at this reference. The same rank-six chart also carries the two observed matrices of Section 8.2 to $B_g^{\mathrm{T}} I_{\times} B_g$ and $B_g^{\mathrm{T}} I_{\times,\mathrm{prof}} B_g$. On their six-dimensional image their generalised fractions are exactly those reported above. Thus the calculated observation and bath effects survive this archived gauge pullback; the pullback does not select their physical weighting.

The chart and the expanded score insertion are derivatives on stated backgrounds, rather than a transition law for the evolving field, current and record together. Neither specifies an embedding of the 140-coordinate Gaussian process in that 600-current-coordinate carrier or the field-dependent update of its marked instrument. Those data are needed to insert this coupling into the joint Gaussian transfer and remove Section 5's product assumption. The mixed derivative just evaluated is a genuine mark-clock derivative; it does not determine an extra hypercharge stiffness beyond the static 0.68 per cent effect in Table 4.

9 Raw pressure and source weight sensitivity

The raw Gaussian transfer carries a source-dependent normalisation that a row-normalised transition matrix removes. For fixed flat diffusion and positive parent H, its leading eigenvalue obeys

$$\ell(H,h) = \log\lambda_0 = -\tfrac{1}{2}\log\det D, \qquad D = I + hR + \tfrac{h^2}{2}H, \qquad R^2 = H + \tfrac{h^2}{4}H^2. \quad (30)$$

The archived parent is affine in closure weight a, record-composition weight b and bond weight c. At their unit values, write $H_i = \partial_i H$. Holding diffusion and the static fermion term fixed, its derivatives are obtained from

$$RR_i + R_iR = H_i + \tfrac{h^2}{4}(HH_i + H_iH), \quad (31)$$

$$RR_{ij} + R_{ij}R = \tfrac{h^2}{4}\left(H_iH_j + H_jH_i\right) - R_iR_j - R_jR_i. \quad (32)$$

With $D_i = hR_i + h^2H_i/2$ and $D_{ij} = hR_{ij}$,

$$\ell_i = -\tfrac{1}{2}\mathrm{Tr}(D^{-1}D_i), \qquad \ell_{ij} = -\tfrac{1}{2}\mathrm{Tr}\left(D^{-1}D_{ij} - D^{-1}D_jD^{-1}D_i\right). \quad (33)$$

These equations retain the normalisation contribution explicitly. They are evaluated on the same seven-alias, 140-real-coordinate parent as Section 5. The scalar unit weights, fixed diffusion and absence of

radial matter remain model premises. Independent eigenvalue evaluations, $\ell = -\sum_j \operatorname{arsinh}\left(h\sqrt{\lambda_j(H)}/2\right)$, verify the pressure and its first and second derivatives by finite differences.

Table 11. Bosonic unit-parent sensitivities at $h = 1$. Static columns reproduce [1, Table 38]. The pressure column differentiates the raw normalisation, not the static stiffness.

Source weight	Static relative derivative range	Raw pressure derivative
Closure a	0.639996 to 0.643208	−11.153529
Record composition b	0.202138 to 0.204667	−11.404157
Bond c	0.154652 to 0.155339	−10.134723

The three static stiffness derivatives sum to K. Their ranges are not probabilities and cannot be added endpoint by endpoint. The raw pressure is −239.517453; its weight Hessian, in the order (a, b, c), is

$$\ell_{ij} = \begin{pmatrix} 9.129889 & 0.281986 & 1.122809 \\ 0.281986 & 9.502616 & 1.206199 \\ 1.122809 & 1.206199 & 6.899686 \end{pmatrix}. \quad (34)$$

With the inherited static fermion curvature included, the raw pressure is −239.432955 and the gradient is $(-11.221717, -11.406729, -10.143487)$. The full Hessian is retained in the archive. Thus the measure contribution is computable and nonzero in the stated model; it is not supplied by the static Schur response alone.

For the numerical small-step limit, define $\mathcal{E} = -\ell/h$. Then $\mathcal{E} \to 1/2\,\mathrm{Tr}\sqrt{H}$. Table 12 gives the derivatives of this quantity in the bosonic model. It is a Gaussian model limit, not a selected physical clock or physical continuum admission.

Table 12. Derivatives of the raw Gaussian energy with respect to the source weights.

Numerical step h	Closure a	Record composition b	Bond c
1	11.153529	11.404157	10.134723
1/4	31.747791	33.479104	24.420576
1/16	46.114798	47.946164	31.218879
Limit $h \to 0$	48.049993	49.788522	32.020859

A physical gauge perturbation requires its own $w_i(\theta)$, where $w = (a, b, c)$, together with any other parent, diffusion and recording derivatives. Even on this restricted weight family the required pullback is

$$\partial_{\theta_\alpha}\partial_{\theta_\beta}\ell = \sum_{ij} \ell_{ij}\, w_{i,\alpha} w_{j,\beta} + \sum_i \ell_i\, w_{i,\alpha\beta}. \quad (35)$$

Equations (33)–(35) therefore supply previously unevaluated coefficients for that calculation. They do not justify adding the numbers in Table 11 directly to a gauge stiffness. In particular, the static map of Section 8.5 does not determine these source-weight derivatives.

10 Joint current evolution and the recording operation

10.1 The exact joint current increment

The source separates the constitutive current residual from the current itself [6, Section 13]. Write $d_J = J - \kappa(\rho_t - U\rho_s)$, with the endpoint states, link and residual treated as independent coordinates. For a left link change $U' = VU$, endpoint increments $\delta\rho_t, \delta\rho_s$ and final residual d'_J, substitution gives

$$\begin{aligned} J' &= VJ + \eta, \\ \eta &= \kappa[(I - V)\rho_t + \delta\rho_t - VU\delta\rho_s] + d'_J - Vd_J. \end{aligned} \quad (36)$$

This finite identity is verified on twelve noncommuting link changes with nonzero residuals and endpoint increments. It neither imposes $d_J = 0$ nor supplies the joint distribution of the increments. In the right-link chart $U(\theta) = U\exp(i\theta_a T_a)$, holding the endpoints and residual fixed for the local derivative gives

$$J_{,a} = -i\kappa UT_a\rho_s, \qquad J_{,ab} = \frac{\kappa}{2}U(T_aT_b + T_bT_a)\rho_s. \quad (37)$$

Applying the archived edge-cycle projection reconstructs the 600×72 real Jacobian A_g of Section 8.5, with rank 72 and Frobenius norm 0.2358591794894311. Finite differences verify both derivative orders. The gauge-induced current is therefore evaluated through the link and endpoints, not inferred from a rotation of J alone. The archived reference has identical endpoints, identity links and zero current, with $\kappa = 1/31$. These are properties of this fixture, not a selection of the physical background.

10.2 A quadratic occurrence law joined to the native recorder

The current-rigidity source permits a binary event whose occurrence intensity starts quadratically in the current; a linear current-to-record amplitude is one sufficient implementation [8, Sections 24–27]. To test whether the existing current-ray recorder already supplies that implementation, let $p_r(J; w)$ be its seven-terminal probability for incoming state w. The explicit hypothesis is

$$q_r(J; w) = \| J \|^2 \, p_r(J; w), \qquad q_r(0; w) = 0. \quad (38)$$

Here q_r is an unnormalised occurrence weight. Its sum is exactly $\| J \|^2$. The hypothesis joins two source constructions; it is not an inherited identity for the complete physical event. The native operation depends on J through its normalised ray. With $\varrho_J = |J\rangle\langle J|/\| J \|^2$, its pointer operators are $K_a = i[T_a, \varrho_J]$, with the maximal-positive complement retained. The calculation uses the archived operation without modifying its pointer metric.

Proposition 9 (quadratic regularity of a ray-dependent rate). Fix w. If a degree-two homogeneous occurrence weight $q(J)$ is twice Fréchet differentiable at $J = 0$, it is a quadratic form and satisfies

$$\mathcal{D}(x, y) = q(x + y) + q(x - y) - 2q(x) - 2q(y) = 0. \quad (39)$$

Proof. Homogeneity gives $q(0) = 0$ and $Dq(0) = 0$. Taylor expansion along tJ, divided by t^2 and followed by $t \to 0$, gives $q(J) = 1/2\, D^2q(0)[J, J]$. Every quadratic form satisfies the displayed identity. The argument applies component by component to recorded outcomes.

The test uses the archived prime-chirp state projected onto the neutral-reference rank-49 support. The directions are the normalised currents generated by the first colour generator, first weak generator and conventional hypercharge. Table 13 gives the seven-component defect. The relative value divides its norm by $2 \| q(x) \| + 2 \| q(y) \|$.

Table 13. Failure of quadratic regularity for the proposed radial attachment. These are consistency residuals, not force-screening fractions.

Current directions	Defect norm	Relative defect
Colour and weak	0.05550222	0.02964976
Colour and hypercharge	0.05853275	0.03165780
Weak and hypercharge	0.05968593	0.03201303

Scaling both directions by $1, 10^{-1}, 10^{-2}, 10^{-3}$ leaves $\mathcal{D}/h^2$ unchanged to numerical precision. The sum over terminal types vanishes, so the total occurrence weight conceals the failure. The quadratic control $q_r(J) = \| P_r J \|^2$ passes the same identity. A scalar envelope $g \| J \|^2 + o(\| J \|^2)$ with $g > 0$ retains the nonzero leading defect. A quartic envelope removes the quadratic contribution; its scaling is verified separately.

This is a local test of the smooth model used to extract a quadratic response. It does not require a partially completed primitive fact. It excludes this attachment as a twice-differentiable local occurrence law at zero current, not the complete nonlinear coarse-grained dynamics or a source-selected nonzero-current background.

10.3 The same test on the archived gauge path

The current-direction test is also executed through an actual archived link change. Both the induced current and the incoming state are varied:

$$w(\theta) = U \exp(i\theta_a T_a)\rho_s, \qquad J(\theta) = \kappa[\rho_t - w(\theta)]. \quad (40)$$

Let $q_{\mathrm{path}}(\theta) = \| J(\theta) \|^2\, p\big(J(\theta); w(\theta)\big)$ and $E_h(v) = \big[q_{\mathrm{path}}(hv) + q_{\mathrm{path}}(-hv)\big]/(2h^2)$. The even combination removes odd finite-link terms. Table 14 evaluates the norm of $E_h(x+y) + E_h(x-y) - 2E_h(x) - 2E_h(y)$ for the paired generator coordinates. The nonzero limits agree with the leading current-map calculation.

Table 14. Parallelogram residual along the joint link, current and incoming-state path. Hypercharge uses the archived primitive coordinate $q = 6Y$.

Gauge directions	$h = 10^{-2}$	$h = 10^{-4}$	Leading limit
Colour and weak	4.6142991×10^{-6}	4.6142877×10^{-6}	4.6142877×10^{-6}
Colour and hypercharge	1.6693003×10^{-5}	1.6679272×10^{-5}	1.6679271×10^{-5}
Weak and hypercharge	1.8958602×10^{-5}	1.8954937×10^{-5}	1.8954937×10^{-5}

The archive also retains the intermediate step $h = 10^{-3}$. The discrepancy from the leading vector decreases quadratically with h. The gauge chart uses $q = 6Y$, whereas the native pointer operation uses conventional Y. Their generator arrays coincide after conversion. Keeping the native operation fixed while changing the gauge-coordinate convention does not rebuild its pointer contraction with an identity metric in the rescaled basis.

10.4 A smooth linear-current construction and its scope

The sufficient linear-current route identified in [8] admits an explicit probability-preserving construction. Let Ω be a unit neutral reference, P_r orthogonal central projectors summing to the identity, and $g \parallel J \parallel^2 \leq 1$. Define

$$L_r(J) = \sqrt{g}\,|P_r J\rangle\langle\Omega|, \qquad L_0(J) = I + \left[\sqrt{1 - g \parallel J \parallel^2} - 1\right]|\Omega\rangle\langle\Omega|. \quad (41)$$

Proposition 10 (smooth current occurrence channel). The operators satisfy $L_0^\dagger L_0 + \sum_r L_r^\dagger L_r = I$. On incoming state Ω, the recorded probabilities are $g \parallel P_r J \parallel^2$, with the remaining probability assigned to no event. If Ω is gauge neutral and the projectors commute with the gauge representation, the construction is gauge covariant.

Proof. The recorded effects sum to $g \parallel J \parallel^2 |\Omega\rangle\langle\Omega|$, which the complementary effect subtracts from the identity. Acting on Ω gives the stated probabilities. For a gauge transformation V, neutrality and $[V, P_r] = 0$ give $L_r(VJ) = VL_r(J)V^\dagger$, including the complementary operator.

Completeness, probabilities and covariance are checked on the seven inherited species groups Q, U, D, L, E, N and H. The formula allows an orthogonal mark refinement, but this execution does not prove the twelve-component event identification of [8]. The neutral incoming reference has a primitive-birth interpretation under the premises of [12]; it differs from the native active rank-49 preparation. Section 11 evaluates the corresponding birth and current-record composition.

For the linear gauge-induced current, averaging the endpoint state over $\Pi/49$, where $\Pi = I - |\Omega\rangle\langle\Omega|$, gives the quadratic occurrence coefficient

$$\mathcal{Q}_{ab} = \frac{g\kappa^2}{49}\,\mathrm{ReTr}(\Pi T_a T_b), \qquad (Z_C, Z_W, Z_Y) = (6, 13/2, 21/2). \quad (42)$$

The primitive hypercharge trace is 378 and becomes $21/2$ on division by 36. These are coefficients of the quadratic occurrence weight; its Hessian is twice this matrix. Neither is identified with the physical gauge-action stiffness. The calculation recovers the baseline representation traces, not the unequal D41 reductions.

The common g is left symbolic; $g = 1$ in the channel verification is a numerical convention. This does not alter PCN's established action unit. The complete physical event operation and its attachment to that unit remain to be identified. Section 11 derives an exact equality of its recorded effects with a composition of inherited birth and current-record maps. That connection does not equate their output states, energy exchange or subsequent histories, and does not establish complete-source selection.

11 Birth current and retained recording

11.1 The inherited birth and endpoint maps

The linear-current construction has an explicit connection to the primitive-birth programme. Its neutral ray, active tangent and support-changing family $B(z) = |z\rangle\langle\Omega|$ are inherited from [12, Theorems 32.3, 32.4 and 32.7]. Those results supply a conditional birth construction and its component probabilities; they do not derive its complete action-level selection. The current source identifies this birth with the endpoint innovation only under a same-event premise [13, Section 19K]. The shared-interface result [15] locates one record readable from both sides, but does not itself supply the 49-dimensional endpoint update.

The maps can nevertheless be composed and tested without a measured coupling. Let $z \perp \Omega$, $\| z \| = 1$, and let the six rim entries of a normalised wheel mode satisfy $|u_v|^2 = 1/6$. On the finite trivial-link chart,

$$\psi_v = \frac{\Omega + \epsilon u_v z}{\sqrt{1+\epsilon^2 |u_v|^2}}, \qquad J_e = \frac{\kappa\epsilon(u_t - u_s)}{\sqrt{1+\epsilon^2/6}} z \quad \text{on rim edges.} \quad (43)$$

The second equality follows from $J_e = \kappa(\psi_t - \psi_s)$: equal rim normalisations cancel the neutral components exactly. Thus the current retains the internal birth ray at finite amplitude, not only in the tangent limit. Both explicit Fourier modes $k = 1,2$, all six rim edges and $\epsilon = 10^{-4}$, 0.2,1 are checked. The finite cancellation is not asserted for spokes, whose endpoint normalisations differ. The chart is a supplied birth branch, not a selected physical background.

11.2 Resolved birth followed by the native operation

Suppose a primitive birth resolves a terminal r, retains its event flag and type, and supplies a state $z_r = P_r z/\sqrt{p_r}$ with $p_r = \| P_r z \|^2 > 0$. Evaluate the inherited native current channels on that branch: $\rho_r = |z_r\rangle\langle z_r|$, $K_a = i[T_a, \rho_r]$, $C_a = \sqrt{\eta} K_a$, with the complete positive complement C_0. When all K_a vanish, take $C_0 = I$. No saturation prescription is required for the following result.

Proposition 11 (retention of a resolved birth type). On this branch the complete native terminal readout preserves the birth probabilities. In particular, for $b_r(J) = \sqrt{g}\, P_r J$ and $M_{\alpha r}(J) = C_\alpha(\rho_r)|b_r(J)\rangle\langle\Omega|$, where ρ_r is the normalised ray of $P_r J$, its recorded effects obey

$$\sum_\alpha \| P_s C_\alpha z_r \|^2 = \delta_{sr}, \qquad \sum_\alpha M_{\alpha r}^\dagger M_{\alpha r} = g \| P_r J \|^2 |\Omega\rangle\langle\Omega|. \quad (44)$$

Proof. The generators commute with all central terminal projectors. Since ρ_r is supported in sector r, it also commutes with them; hence so do the commutators, their summed positive effect and its complementary square root. Each channel preserves the occupied sector. Summing the complete channel family gives unit probability within that sector, and the second identity follows by applying completeness to b_r.

The resulting effects are exactly those of Proposition 10. This connects its smooth probabilities to the inherited resolved-birth and native-current maps. It establishes more than preservation of a stored label: the subsequent terminal readout itself has the same probabilities. It does not identify the complete quantum operations. The native channels can change the state inside a terminal sector, so equality of one-event effects does not establish equality of subsequent histories.

The retained birth flag is essential. A resolved charged Abelian singlet has $[T_a, \rho_r] = 0$ for every generator, so it remains in the C_0 channel. Counting only later nontrivial native jumps would discard a genuine birth. Likewise, a neutral birth is not distinguished from absence of birth by the neutral terminal label alone. Neither the flag's permanent absorption nor the physical value of g is derived by Proposition 11. Section 12 derives its exact probability coefficient along the finite birth path and tests a continuation to independent currents.

11.3 Reversing the recording order

If the native instrument acts on the unresolved current ray z before birth-type resolution, the result differs. Define $\mu_a = \langle z|T_a|z\rangle$, $V = \sum_a (\langle T_a^2\rangle - \mu_a^2) > 0$ and an occupied incoming state $\sqrt{1-\beta}\,\Omega + \sqrt{\beta}\, z$. The nontrivial native channels have total probability $\eta\beta V$. Their conditional terminal distribution is

$$q_r = \frac{\sum_a \| P_r (T_a - \mu_a) z \|^2}{V} = \frac{p_r F_r}{V}, \qquad F_r = \sum_a \| (T_a - \mu_a) z_r \|^2. \quad (45)$$

This follows directly from $K_a z = i(T_a - \mu_a)z$ and $K_a \Omega = 0$. The original Born probabilities are recovered precisely when $F_r = V$ on every occupied terminal. The conditional comparison is independent of η wherever nontrivial events occur.

Table 15. Recording order for $z = (e_0 + e_{14})/\sqrt{2}$ in the inherited Q and E sectors. Each row conditions on the stated event; it does not equate the event rates. Here $V = 89/72$.

Operation and retained event	Q probability	E probability
Primitive birth readout	$1/2$	$1/2$
Unresolved ray then nontrivial native current event	$143/178$	$35/178$
Resolved birth then complete native terminal readout	$1/2$	$1/2$

The numbers also follow from the representation traces directly. The occupied-sector Casimirs are $C_Q = 4/3 + 3/4 + (1/6)^2 = 19/9$ and $C_E = 1$, while the squared generator means sum to $\sum_a \mu_a^2 = 23/72$. Hence $V = \big(C_Q + C_E\big)/2 - 23/72 = 89/72$. Inserting the sector means into $F_r = C_r - 2\sum_a \mu_a \langle T_a \rangle_r + \sum_a \mu_a^2$ gives $F_Q = 143/72$ and $F_E = 35/72$, and therefore $q_Q = 143/178$ and $q_E = 35/178$.

The middle row is approximately 80.34%: 19.66%. The difference is reproduced on the finite rim chart, survives the small-amplitude limit and is gauge-frame invariant. Eighty independent active complex rays verify both the conditional law and Proposition 11. They are algebraic verification samples, not a selected physical ensemble. The distinction between these orders prevents a successful birth-record composition from being attributed to a different current-first operation.

11.4 Circulating currents and spatial normalisation

The endpoint connection does not cover the whole factor-radial force-current tangent. Its edge profile is $y_\mu = q_\mu q_+$, where $q_\mu = B^T u_\mu$ and $q_+ = (q_c + i q_s)/\sqrt{2}$. Endpoint variations lie in imB^T, whereas the orthogonal cycle projector annihilates that image. The explicit CRTF-EX2N edge table [13] reproduces the inherited 3/5 cycle fraction [16, Section 24.20]. This cycle is already carried by the full MASD current defect: $P_{\mathrm{cyc}} \delta D_J = P_{\mathrm{cyc}} \delta J$. Its magnitude-bearing physical record map is not identified by the endpoint-birth composition.

Numerical transmission also requires an explicit mode convention. The CRTF-EX2N edge table uses the period-three $k = \pm 2$ doublet with Laplacian eigenvalue 4. In contrast, [14, Section 18.4] selects $k = \pm 1$ with eigenvalue 2, but its Section 20.2 quotes the norm 4 inherited from the other doublet. For a unit vertex vector and the same incidence, $\| B^T u \|^2 = u^\dagger B B^T u$ fixes the norm to the eigenvalue. Rebuilding both bases gives Table 16.

Table 16. Explicit unit-normalised wheel modes. The cycle fraction refers to the squared norm of y_μ, not a force reduction.

Quantity	$k = 1$	$k = 2$
Laplacian eigenvalue and $\| q_+ \|^2$	2	4
Rim $\|q_+\|^2$	$1/6$	$1/2$
$\| y_\mu \|^2$	$1/3$	$5/3$
$\| P_{\mathrm{cyc}} y_\mu \|^2$	$1/6$	1
Cycle fraction	$1/2$	$3/5$

The $3/5$ result is correct for its supplied $k = 2$ arrays; a common label E_2 does not transfer it to $k = 1$. Proposition 11 holds for both modes. None of Sections 2–10 is rescaled on this basis: those executions retain their archived arrays and distinct scalar-mode conventions. Section 12 therefore evaluates the birth probability and gauge response separately for both spatial branches, without identifying their numerical scales.

12 Event rates and circulating current response

12.1 The executed record rate

The inherited ordered-record architecture counts a nonself address transition as a recorded crossing and retains every conditional native channel, including C_0. Completeness gives its fact effect $(1 - T_{xx})I$ at address x. With the archived stationary law, the mean number of recorded crossings per primitive step is

$$\bar{h}_{\mathrm{cross}} = \sum_x \pi_x \, (1 - T_{xx}) = 0.810576269094213. \quad (46)$$

The hub probability is $6/7$ and each rim probability is 0.799694113793042. This is the stationary rate corresponding to the crossing count in Section 4.3. It is neither a completed-cover rate nor the probability of a nontrivial current Kraus jump. With this address law fixed, the fact effect has zero current derivative to every order, as [8, Section 39H] establishes. This fixed-law result does not exclude current dependence of the address law in a complete interacting source.

The resolved-birth event in Proposition 11 has a different flag. On the normalised rim chart of Section 11.1 its occurrence probability is $\beta = \epsilon^2/(6 + \epsilon^2)$. Defining g_{b} by $\beta = g_{\mathrm{b}} \| J_e \|^2$ gives the exact finite-path identity

$$g_{\mathrm{b}} \kappa^2 = \frac{1}{2[1 - \cos(2\pi k/6)]} = \eta_k, \qquad \eta_1 = 1, \quad \eta_2 = \tfrac{1}{3}. \quad (47)$$

The two values use the distinct spatial normalisations in Table 16. They are probability coefficients in source coordinates. The integrated hazard is $-\log(1 - \beta)$, whose coefficient relative to $\| J_e \|^2$ has the additional factor $-\log(1 - \beta)/\beta$. No finite-amplitude probability is silently identified with an intensity. The birth-path identity and its transverse-current qualification agree with [8, Section 38] and [18].

12.2 A complete finite event

For the test, assign separate edge/type birth outcomes $L_{er} = \sqrt{g_{\mathrm{b}}} \, |P_r J_e\rangle\langle\Omega|$ and the no-birth complement, on the domain $g_{\mathrm{b}} \sum_e \| J_e \|^2 \leq 1$. Apply the complete native operation to each resolved branch. Proposition 11 then gives exactly $\sum_\alpha M_{\alpha er}^\dagger M_{\alpha er} = g_{\mathrm{b}} \| P_r J_e \|^2 \, |\Omega\rangle\langle\Omega|$. All twelve edges, seven terminal

groups, the no-birth complement and zero-commutator sectors are included in the execution. The type probabilities survive, while the output density matrix within a type can change.

This is a bounded one-event completion of the established probability connection. Its fresh neutral input, edge-resolved birth alphabet and continuation to independent currents are declared parts of the test. It does not identify that birth flag with the crossing architecture of Section 12.1. The output state, rather than its type alone, must be carried into a subsequent joint event. Sections 12.5–12.6 calculate that state and distinguish its regularity from that of the terminal effects.

12.3 The full gauge derivative

Keep the finite birth endpoints and change the links by $U_e = \exp(i \sum_{ma} Q_{em}\, \theta_{ma} T_a)$, where $Q^{\mathsf{T}} Q = I_6$ and $BQ = 0$. Here B is the vertex-edge incidence and all twelve T_a use conventional hypercharge Y. The endpoint current is $J_e = \kappa(\psi_t - U_e \psi_s)$. For a fixed orthogonal spatial projector P, its quadratic event weight $p_P = g_{\mathrm{b}} \parallel PJ \parallel^2$ has Hessian

$$\partial_i\, \partial_j p_P = 2 g_{\mathrm{b}} \mathrm{Re}\big[(\partial_i J)^{\dagger} P (\partial_j J) + J^{\dagger} P (\partial_i\, \partial_j J)\big]. \quad (48)$$

The second term follows the current's own second-order change; it cannot be omitted on this nonzero background. The calculation evaluates $P = I$, P_{grad} and $P_{\mathrm{cyc}} = QQ^{\mathsf{T}}$ separately. These are the frozen linearised source projectors at $U = I$, not a nonlinear non-Abelian Hodge decomposition at arbitrary links.

Proposition 12 (probability curvature on the finite birth chart). Average the active internal ray with second moment $\Pi/49$, as a declared invariant probe. Let $G = \mathrm{diag}(6I_8, (13/2)I_3, 21/2)$ and $M = Q_{\mathrm{rim}}^{\mathsf{T}} Q_{\mathrm{rim}}$. The complete event-probability Hessian on the 72 cycle-link coordinates is

$$H_p = S_k \otimes \tfrac{G}{49}, \qquad S_k = 2\eta_k \beta \cos(2\pi k/6) M. \quad (49)$$

Proof. Write $\psi_v = c_v \Omega + a_v z$, with $a_v = \epsilon u_v c_v$ and $c_v = (1 + \epsilon^2 |u_v|^2)^{-1/2}$. Since $T_a \Omega = 0$, the generator-dependent part of the edge norm is determined by $a_t^* a_s \mathrm{Tr}(\Pi U_e)/49$. Its second derivative is $2\kappa^2 \mathrm{Re}(a_t^* a_s) G/49$. On rim edges $a_t^* a_s = \beta \exp(-2\pi i k/6)$; on spokes $a_s = 0$. Pulling back through Q and multiplying by g_{b} proves the formula.

Table 17. Exact spatial probability curvature. Each entry in the last two columns multiplies M; none is a physical force coefficient.

Rim mode	$g_{\mathrm{b}} \kappa^2$	Complete S_k/β	First-derivative term alone
$k = 1$	1	1	2
$k = 2$	1/3	$-1/3$	2/3

Writing $\theta_k = 2\pi k/6$ makes the sign transparent: the first-derivative term is $\beta M/(1 - \cos\theta_k)$, the contact term is exactly $-\beta M$, and $S_k/\beta = \cos\theta_k M/(1 - \cos\theta_k)$. Among the nontrivial rim modes this is positive only for $k = 1$ (and its conjugate); it is negative for $k = 2$ and the alternating $k = 3$. The latter gives $-M/2$ and is an algebraic mode control, not a selection of a third physical birth branch.

The projected circulating-current contribution is positive and has rank 72 in both modes. Their spatial eigenvalues, divided by β, lie in [0.1,1] for $k = 1$ and [1/15,1/6] for $k = 2$. The cycle contact term vanishes because $P_{\mathrm{cyc}} J = 0$ at the unperturbed endpoint configuration. The gradient contribution supplies the remaining contact term; at $k = 2$ it outweighs the positive cycle response and makes the total probability curvature negative definite. This describes a probability around a supplied birth background, not a negative gauge stiffness or a physical instability.

The integrated-hazard Hessian is evaluated separately as $H_\Gamma = H_p/(1-p) + (\nabla p)(\nabla p)^\top/(1-p)^2$. Its extra term is hypercharge-only on this probe because only Y has nonzero trace on the stated census. It is a probability-normalisation contribution, not the D41 reduction. Exact formulae, finite non-Abelian link differences and the gradient-plus-cycle identity agree in all tested directions.

12.4 Comparison with the source action

The positive current-link response is retained independently. On the unit diagonal source branch of [8, Sections 39A–39F], elimination of the conjugate current and record phase gives $K_{\mathrm{link}}(\lambda) = \lambda + \lambda/(\lambda+1)$ and $K_J = K_{\mathrm{link}}/(K_{\mathrm{link}} + 1/2)$. The four mode pairs $\left(K_J, K_{\mathrm{link}}\right)$ are (3/4,3/2), (16/19,8/3), (48/53,24/5) and (35/38,35/6) for $\lambda = 1,2,4,5$. They obey the same-parent reciprocity identity $K_J^{-1} = 1 + (2K_{\mathrm{link}})^{-1}$.

The PCN conversion is also retained: [17, Section 9.10] supplies $t = 0.0215626456584632$, with the conditional action coefficients multiplied by $1/t$. At $\lambda = 4$ this gives $K_J = 42.0013569625685$ and $K_{\mathrm{link}} = 222.607191901613$ in that source convention. The source distinguishes this normalised parent from its identification as the complete physical history core. The unresolved calculation therefore does not reopen PCN's unit or call for another conversion constant.

The sign test excludes a blanket substitution of event-probability or hazard curvature for the positive source stiffness. Positive finite-cell continuations $g_{\mathrm{b}}\left(\| P_{\mathrm{grad}} J \|^2 + \gamma \| P_{\mathrm{cyc}} J \|^2\right)$ further agree on every endpoint-generated current while differing on independent cycles. The values $\gamma = 1/2,1,2$ verify this distinction; they are not certified alternatives to the complete physical source. Locality and the actual transported dynamics may select or exclude them.

The established probability connection has thus been carried through an explicit finite event and its second-order gauge response. Combining that event with the field, current, record, completion and matter energy exchanges still requires their common evolving source law. Neither the fixed address rate nor the positive action block supplies that joint law on its own.

12.5 Returned state and internal-energy change

The terminal effects of Proposition 11 do not specify the state passed to the next event. That state can nevertheless be returned exactly for the same resolved-birth, current-aligned branch. Let z be its unit internal ray, supported in one terminal sector, and put $\rho = |z\rangle\langle z|$, $\mu_a = \langle z|T_a|z\rangle$ and $s = \sum_a \| (T_a - \mu_a) z \|^2$. The inherited native instrument has $K_a = i[T_a, \rho]$, $C_a = \sqrt{\eta} K_a$ and $C_0 = (I - \eta \sum_a K_a^2)^{1/2}$ [2, Section 66]. For $s > 0$, write $\chi = \eta s \in [0,1]$. The archived maximal-positivity prescription is $\chi = 1$; positivity alone does not select that endpoint. This conditional native activity is distinct from the probability that a birth occurs.

Proposition 13 (resolved native state and energy response). The nonselective output, including C_0, is

$$\rho_{\mathrm{out}} = (1-\chi)\rho + \frac{\chi}{s} \sum_a (T_a - \mu_a)\, \rho\, (T_a - \mu_a). \quad (50)$$

At $s = 0$ the zero-commutator prescription gives $\rho_{\mathrm{out}} = \rho$. At $\chi = 1$ and $s > 0$, the output is supported orthogonally to z. Every terminal projector and every sector Casimir $\mathcal{C}_F = \sum_{a \in F} T_a^2$ is preserved by this resolved-sector channel. For any specified Hermitian internal-energy observable $\mathcal{H}$, the exact change at fixed event inputs is

$$\Delta E = \mathrm{Tr}[\mathcal{H}(\rho_{\mathrm{out}} - \rho)] = \langle z|\mathcal{E}_z^*(\mathcal{H}) - \mathcal{H}|z\rangle, \qquad \mathcal{E}_z^*(\mathcal{H}) - \mathcal{H} = -\frac{1}{2}\sum_{\alpha=0}^{12}\left[C_\alpha, [C_\alpha, \mathcal{H}]\right]. \quad (51)$$

Proof. The vectors $v_a = (T_a - \mu_a)z$ are orthogonal to z. Direct multiplication gives $K_a z = i v_a$ and $\sum_a K_a^2 = \sum_a |v_a\rangle\langle v_a| + s\rho$. Hence $C_0 z = \sqrt{1-\chi}\, z$, giving the output and its orthogonality at maximal activity. On a resolved terminal support, its projectors and the Casimirs commute with every C_α. Completeness therefore fixes those observables. All C_α are Hermitian, and expanding their double commutators with $\sum_\alpha C_\alpha^2 = I$ proves the energy identity.

For the finite edge-resolved event of Section 12.2, set $w_{er} = g_{\mathrm{b}} \parallel P_r J_e \parallel^2$, $z_{er} = P_r J_e / \parallel P_r J_e \parallel$ on occupied branches and $p = \sum_{er} w_{er}$. Retaining the no-birth flag and all edge/type flags gives the explicit joint output

$$\varrho_{\mathrm{out}} = (1-p)|0\rangle\langle 0| \otimes |\Omega\rangle\langle\Omega| + \sum_{er} w_{er}\, |e,r\rangle\langle e,r| \otimes \rho_{\mathrm{out}}(z_{er}). \quad (52)$$

Its 85 retained blocks include twelve edges times seven types and the no-birth branch; the unrecorded native microchannel is summed within each block. The native part of the internal-energy change is exactly $\sum_{er} w_{er}\, \mathrm{Tr}[\mathcal{H}(\rho_{\mathrm{out}}(z_{er}) - |z_{er}\rangle\langle z_{er}|)]$. Both finite spatial modes, with noncommuting changed links, reproduce this joint state and energy sum directly from the composed Kraus maps. This returns the retained record and the internal state together for the declared event. It does not specify their subsequent coupled evolution.

The result supplies the full one-event internal output, rather than only its terminal probabilities. For product rays with an unentangled family factor, the fundamental-generator identity gives $\rho_{\mathrm{out}} = (I_d - \rho)/(d-1)$ for a single active $SU(d)$ factor at $\chi = 1$, with the family ray unchanged. For a quark-doublet product $\rho_C \otimes \rho_W$, the output is $(2/3)[(I_3 - \rho_C)/2] \otimes \rho_W + (1/3)\rho_C \otimes (I_2 - \rho_W)$. These formulae give Table 18; they are conditional test states, not a selected physical background distribution.

Table 18. Multipliers of the conditional generator means after the maximal native operation on product rays. "Absent" denotes a factor not carried by that type. These are changes of internal polarisation, not force-strength reductions or changes of representation.

Terminal type	Colour mean	Weak mean	Hypercharge mean
Q	0	$1/3$	1
U, D	$-1/2$	Absent	1
L, H	Absent	-1	1
E, N	Absent	Absent	1

For neutral N, the hypercharge mean is identically zero. For an internal interaction observable linear in the generators, Table 18 also gives the corresponding conditional changes of its colour and weak contributions, with its coefficients held fixed. An energy depending only on terminal projectors or sector Casimirs is unchanged. The complete coupled source energy is not generally of either restricted form; the formula requires its actual operator and cannot supply that operator by itself. In particular, preservation of a Casimir does not establish preservation of unequal-time current correlations or of the physical gauge stiffness. The record and other source components must carry any compensating energy change in a conserved complete event, but their evolution is not reconstructed from this internal identity.

The cross-paper energy consequence has a precise scope. If the internal energy is a function only of the terminal projectors and sector Casimirs, this native step cannot supply any compensating internal-energy change. If the same field protocol and energy convention of [1, Table 16] survived in a joint event, its 0.169 ± 0.011 model-unit gain would then have to be offset by current, record, completion or other interaction energy. That gain is a matching target for the restricted protocol, not an immutable prediction of the complete source.

Gauge invariance alone is not enough to exclude internal matter energy. The census has repeated family representations. On the resolved L sector take $z = \sqrt{3/4}\,|g_1 w_1\rangle + (1/2)|g_2 w_2\rangle$ and the gauge-invariant energy projector $\mathcal{H} = |g_2\rangle\langle g_2| \otimes I_2$. It commutes with all twelve generators, but the native step changes its expectation from $1/4$ to $17/44$, a gain of $3/22$. For a pure family–fundamental state with family marginal R and $t = \mathrm{Tr}R^2$, the generator completeness identity gives $R_{\mathrm{out}} = [(d+t)R - 2R^2]/(d-t)$ at maximal activity. Here $d = 2$ and $t = 5/8$. This exact control is not a proposed physical energy or a match to the field gain; it prevents Casimir preservation from being overstated as preservation of every gauge-invariant energy. For a pure family–fundamental state the activity is $s = (d - \mathrm{Tr}R^2)/2$. Its normalising scalar depends only on purity; the returned family matrix still depends on R and R^2, not on purity alone.

12.6 State-level regularity at zero current

The exact output also permits a test beyond the terminal-probability result. On a resolved sector, define the unnormalised returned state at maximal native activity by

$$\mathcal{R}(j) = \| j \|^2 \, \rho_{\mathrm{out}}(j/\| j \|), \qquad \mathcal{R}(0) = 0. \quad (53)$$

Its trace is exactly $\| j \|^2$, and multiplication by g_{b} gives that branch's birth weight. Nevertheless, the matrix-valued function need not have a quadratic Taylor coefficient at zero current.

Proposition 14 (a state-level regularity witness). The maximal native operation on the full resolved L carrier makes $\mathcal{R}$ fail twice-differentiable regularity at $j = 0$, despite its quadratic terminal probabilities.

Proof. Choose two families and the two weak components, ordered $(g_1 w_1, g_1 w_2, g_2 w_1, g_2 w_2)$. Let $x = g_1 w_1$ and $y = g_2 w_2$. The product inputs return $g_1 w_2$ and $g_2 w_1$ respectively. The normalised rays $(x \pm y)/\sqrt{2}$ have maximally mixed weak marginal and $s = 3/4$; the Pauli completeness identity gives output $\left(I_4 - |z_\pm\rangle\langle z_\pm|\right)/3$. Consequently,

$$\mathcal{R}(x+y) + \mathcal{R}(x-y) - 2\mathcal{R}(x) - 2\mathcal{R}(y) = \tfrac{2}{3}\mathrm{diag}(1,-1,-1,1). \quad (54)$$

The defect has zero trace and Frobenius norm $4/3$. Since $\mathcal{R}(hj) = h^2\mathcal{R}(j)$ for real h, its scaled defect is unchanged arbitrarily close to zero. The componentwise argument of Proposition 9 excludes a quadratic Taylor coefficient there.

The execution also finds nonzero state defects for colour–weak entanglement in Q and family–colour entanglement in U, while the single Higgs doublet and fixed-family colour examples obey their explicit quadratic formulae. This result preserves Proposition 11's exact terminal effects. It identifies a regularity obligation of the proposed full output operation, not a failure of VERSF's eventual coarse-grained action: coarse graining or a different source-selected recording operation could change this local behaviour. The exact state map is smooth on each nonzero resolved non-Abelian branch, where its variance denominator obeys $s \geq 3/2$ on Q, $s \geq 1$ on U, D and $s \geq 1/2$ on L, H. It can therefore be inserted into a supplied nonzero-background joint evolution without pretending that terminal probabilities already specify that evolution.

13 Retained histories and fact momentum feedback

13.1 What the repeated native operation retains

The unresolved-current instrument of [2, Section 66] can be iterated on the archived D36 clock while retaining its output state [20]. This is not repetition of Section 12's fresh-neutral-input resolved-birth operation. On each crossing link transport is followed by all thirteen current channels, including the complement, and then terminal readout. Self transitions act as the internal identity. The complete channel

is trace preserving and unital, so $\sigma_x = \pi_x I_{50}/50$ is an exact stationary state for fixed, field-independent address law. No uniqueness or physical selection of this state is asserted. The following information test uses that stationary preparation and the fixed endpoint witness.

A stationary terminal label has probability $d_r/50$, independent of the gauge perturbation. After observing label r, however, the state is P_r/d_r; this is the input to the following crossing. The joint law of two successive labels resolves all 72 cycle-link directions on the archived endpoint witness. Its Fisher matrix, before division by crossing exposure, has smallest eigenvalue 8.69187×10^{-11} and trace 0.00243221. An independent link finite difference verifies the weakest direction. Overlapping pairs are correlated, so this matrix is neither the full-history information rate nor an additive gauge stiffness.

The address-only bath cross block vanishes, to 3.22×10^{-18} in the numerical check, because conditional record scores have zero mean at each fixed address path. This tests that bath restriction; it does not replace the twelve-direction D41 bath. Repetition also fails to preserve an independently renewed 49-state preparation: from that preparation the excluded neutral reference has occupation 0.00074346 after one step and 0.01564148 after 128 steps. These values do not assert a stationary limit or a change of the physical census.

Proposition 15 (complete recording without energetic feedback). Appending complete trace-preserving conditional record channels to an unchanged scalar field-history weight leaves its unconditioned partition sum and pressure derivatives unchanged, even when the internal state is retained.

Proof. For each field history, summing the retained outcomes gives the trace of a composition of trace-preserving channels on a normalised initial state, equal to one. This factor leaves the scalar history weight unchanged. Conditioning on an outcome or changing subsequent energy weights is a different operation.

The pair Fisher matrix has colour, weak and hypercharge block traces 0.000671704, 0.000923629 and 0.000836882 on 48, 18 and 6 coordinates. Dividing by generator multiplicities gives 0.000083963, 0.000307876 and 0.000836882, which do not follow 6: 6.5: 10.5. The best common six-cycle matrix tensored with that charge Gram leaves relative Frobenius residual 0.84765; cross-sector blocks alone contribute relative norm 0.56017. The largest eigenvalue is 3.09374×10^{-4}, so the spectral condition number is 3.55935×10^{6}; trace divided by the smallest eigenvalue is 2.79826×10^{7}, a different diagnostic. All six-cycle sector matrices are archived [22]. Full rank 72 also excludes identifying this entire matrix with a rank-at-most-six pullback of $dH - \Delta m m^{\mathrm{T}}$. It does not exclude a D41 component after a source-defined projection and bath reduction, which this address-only bath control does not supply.

The pair records therefore contain real information about the gauge field even though Proposition 15 makes their complete, unconditioned channel invisible to the scalar pressure. Information retained in outcomes and energetic field response are distinct quantities in this construction.

The proposition does not exclude record backreaction. Fact momentum already supplies such an energetic mechanism [19]. The task is to connect its spatial record carrier and weighting to the current/event carrier, rather than to infer stiffness from the information in a terminal label.

13.2 The inherited energy and the specified attachment

The fact-momentum paper eliminates the scalar field and relaxable record and derives the extra cost of departure from a committed spatial record [19, Sections 3, 6.3 and 7]:

$$E_{\mathrm{lock}}(\rho) - E_{\mathrm{rel}}(\rho) = 1/2\,\langle \rho - \rho_L, K_{\mathrm{pin}}(\rho - \rho_L)\rangle, \qquad K_{\mathrm{pin}} = \lambda^2(\lambda + a - \alpha\nabla^2)^{-1}. \quad (55)$$

Energy and first derivative agree at commitment, while the subsequent response gains a positive term. Here ρ is a spatial commitment density, not an internal density matrix. The same source explicitly

distinguishes that density from the polar record phase [19, Section 9.1]. Its Section 9.2 gives the current residual $D_J = J - \kappa(\rho_t - U\rho_s)$ and the full source Hessian, including residual curvature. The current-rigidity theorem gives $\lambda_A = \lambda_0 \parallel P_A J \parallel^2$ within its positive quadratic same-grain class under AP1b [8, Section 8]. It does not alone identify these spatial and current carriers.

The execution [21] specifies $\rho(z) = \sum_e q_e\, g_s(z - z_e)$ with $q_e = \parallel J_e \parallel^2$, common gain one and twelve Gaussian profiles at edge midpoints of a unit-radius planar wheel. It uses the source's stable diagnostic parameters $A = 1$, $B = 4$, $s = 0.4$, $a/\lambda = 1/2$, $\mu = 2/\sqrt{3}$ and $\nu = 2$. The current residual metric, κ and the action exposure are one; integration uses flat measure on the 49-complex current space per edge. The fixed endpoint vectors are the archived witness, not a selected physical vacuum. These are stated model inputs, not consequences of $K = 7$ alone.

13.3 The current parent and its retained response

Let Q be the orthonormal six-cycle basis of the twelve-edge wheel and let Π_{49} remove the neutral common vector. With $\vartheta_e = \sum_m Q_{em}\, \theta_m$, define

$$j_e(\theta) = \Pi_{49}\big[\psi_y - e^{i\vartheta_e \cdot T}\psi_x\big], \qquad q_e = \parallel J_e \parallel^2. \quad (56)$$

For the Gaussian-smeared Yukawa kernel $Y_{m,s}$ of [19], the edge-profile matrices are

$$(K_{\mathrm{rel}})_{ef} = 12e^{-d_{ef}^2/(4s^2)} - Y_{\mu,s}(d_{ef}) - DY_{\nu,s}(d_{ef}), \qquad \big(K_{\mathrm{pin}}\big)_{ef} = DY_{\nu,s}(d_{ef}), \quad (57)$$

where $D = 7.25997097331$ and the smallest eigenvalue of K_{rel} is 0.57350606. The nonlinear current parent is

$$\Gamma_f = 1/2 \sum_e \parallel J_e - j_e(\theta) \parallel^2 + 1/2\, q^{\mathsf{T}} K_{\mathrm{rel}} q, \qquad \Gamma_l = \Gamma_f + 1/2\, (q - q_*)^{\mathsf{T}} K_{\mathrm{pin}} (q - q_*). \quad (58)$$

For the minimum-pinned control, q_* is the relaxed current minimum at $\theta = 0$. Section 13.7 separately samples realised records from the relaxed ensemble; the minimum is not identified with a typical commitment. The density kernel is positive, and radial symmetry reduces minimisation to twelve amplitudes aligned with the target currents. The selected total intensity is 0.92712364, compared with target intensity 24.67673255. Independent minimisations and exact-link finite differences verify this solution and its retained Hessian.

At this minimum the locked-minus-relaxed gauge increment is positive semidefinite of rank twelve. Its trace is 0.000400531, compared with 0.000487561 when the already-relaxed current path is held fixed: 82.15 per cent survives current readjustment. The Gaussian determinant increment there is 0.486610. These quantities refer to profiling at a specified minimum; they are not the full fluctuation integral.

Writing $b_e(\theta) = \parallel j_e(\theta) \parallel^2$, any integrated or profiled scalar response $F(b)$ has the full gauge Hessian

$$H_g = (Db)^{\mathsf{T}} F_{bb} (Db) + \sum_e F_{b_e}\, H_{b_e}. \quad (59)$$

The second term is retained throughout. Positive radial rescaling leaves the projective recorder unchanged but changes its magnitude-bearing intensity, so an unchanged conditional channel does not imply an unchanged event weight.

13.4 Integrating the unresolved current

The calculation integrates all 1176 real current coordinates, rather than substituting the current minimum. Angular integration is exact in each 98-dimensional real current space. For $r_e = \parallel J_e \parallel$, $a_e = \parallel j_e \parallel$ and $x = a_e r_e$, its normalised angular factor is $2^{48}\Gamma(49) I_{48}(x)/x^{48}$. The remaining twelve radial integrals retain the Jacobian and the complete quartic action.

Eight scrambled Sobol importance rules of 65,536 points per parent, followed by an independent 131,072-point rule with a broader proposal, give Table 19. The action unit and measure are specified inputs. The record remains fixed at q_*, rather than being resampled from a physical completed-event ensemble. For the raw transfer matrix M constructed in Section 13.5, the reported gauge response uses the energy convention $F(\theta) = -\log r\big(M(\theta)\big)$, where r is the Perron root. Thus the tabulated curvature is the negative of the logarithmic pressure curvature.

Table 19. Integrated current and raw-event response in the specified feedback model. Logarithms omit the same constant angular measure factor; intensities and curvatures are model quantities.

Quantity	Relaxed record	Locked record
$\log Z$	−176.29215	−301.66009
Mean total current intensity	15.85974	12.59494
Mean spoke intensity	1.090053	0.882139
Mean rim intensity	1.553237	1.217018
Perron root with all edge means replaced by their common average	1.260755	1.040188
Raw Perron root divided by Z	1.306599	1.073356
Trace of free-energy gauge Hessian	−0.5642361	−0.5660069

The mean intensity falls by 20.5854 per cent. The partition free-energy increment $-\log Z_l + \log Z_f$ is 125.36794; including the event-clock term gives 125.56457. Its large departure from the Gaussian estimate reflects the many current configurations far from the minimum: the minimum has intensity 0.927, whereas the integrated relaxed parent has mean 15.86. The chosen commitment is atypical under this unit-exposure ensemble.

The locked-minus-relaxed free-energy Hessian has trace -0.00177076 and eigenvalues ranging from -0.000199702 to $+0.000178990$. Its empirical trace standard error across the scrambled rules is 3.63×10^{-8}; the broader-proposal result differs by 6.18×10^{-8}. These are convergence diagnostics, not certified integration bounds. Reweighting the original integrand independently verifies the first and second derivatives.

The sign differs from the positive static lock increment. Pointwise $\Gamma_l \geq \Gamma_f$ implies $Z_l \leq Z_f$, but does not order the gauge Hessians of $-\log Z$ at an arbitrary fixed endpoint background. The indefinite difference is therefore compatible with a positive record penalty. It neither establishes a physical vacuum instability nor supplies a negative physical gauge coupling.

13.5 Scalar pressure and the pressure silent native channel

The intensity is attached to the raw transfer with crossing weight $w_{xy}(J) = q_e$ and self weight one. For each step the same current enters the energy, this weight and the complete native channel $\mathcal{E}_{xy,J,\theta}$, including link transport and terminal readout. Integrating the unresolved current gives

$$\mathcal{T}_{xy,\theta} = T_{xy} \int e^{-\Gamma(J;\theta)} w_{xy}(J) \mathcal{E}_{xy,J,\theta}\, dJ. \quad (60)$$

This is a raw positive transfer, not an identification of unbounded intensity with a finite-step probability. Its Doob normalisation gives probabilities. The relative hold/crossing weight is specified. Current configurations are integrated independently at successive steps conditional on the same locked record,

while the internal quantum state is passed forward. This does not supply complete temporal evolution of the independent field and current.

Proposition 16 (raw pressure for the specified integrated transfer). Its Perron radius equals that of the seven-address matrix with $M_{xx} = T_{xx}Z$ and $M_{xy} = T_{xy}Z\langle q_e\rangle$ on crossings.

Proof. In the Heisenberg picture each complete conditional channel is unital. A positive scalar Perron vector times the internal identity is therefore an eigenoperator of the integrated transfer with eigenvalue equal to the Perron root of M. Conjugating by this blockwise positive vector and dividing by that root gives a unital positive map, whose operator norm is one. The spectral radius cannot exceed that root, proving equality. The channels and the scalar weights need not be statistically independent.

Corollary 16.1 (complete recorder cancellation). For this transfer $r(\mathcal{T}) = Zr\big(\widetilde{M}\big)$, where $\widetilde{M}$ depends only on the twelve mean intensities. The complete conditional native channel therefore contributes neither to the raw pressure nor to any of its gauge derivatives. Retaining the internal state preserves its information, but none of Table 19's pressure change comes from the quantum record operation. This is the cancellation of Proposition 15 with current-dependent scalar weights. Breaking it requires a transfer that is no longer scalar on the internal identity, for example outcome-dependent weights or postselection; these are possible mechanisms, not assertions of source selection.

The energy and clock contributions are separated exactly:

$$F(b) = -\log Z(b) - \log r\left(\widetilde{M}(b)\right), \qquad \Delta \mathrm{tr} H_g = \mathrm{tr}[(Db)^{\mathsf{T}} \Delta F_{bb} Db] + \sum_e \Delta F_{b_e} \mathrm{tr} H_{b_e}. \quad (61)$$

Table 20. Origin of the minimum-pinned gauge-Hessian trace difference at unit exposure. The first two rows split the free energy; the last two split its gauge pullback. Each pair sums to the same total.

Contribution	Locked minus relaxed trace
Partition term $-\log Z$	$-1.76843148 \times 10^{-3}$
Clock term $-\log r\big(\widetilde{M}\big)$	$-2.33026033 \times 10^{-6}$
Contact term $\sum_e \Delta F_{b_e} H_{b_e}$	$-1.77072578 \times 10^{-3}$
Quadratic term $(Db)^{\mathsf{T}} \Delta F_{bb} Db$	$-3.59656277 \times 10^{-8}$

The twelve entries of F_b and all 144 entries of F_{bb} are published for each parent, separately for $-\log Z$ and the full F, as CSV files under feedback_controls/results/ [22]. The archive also gives Db, every H_{b_e}, the contact traces and $Db(Db)^{\mathsf{T}}$. These suffice to reconstruct the full response and each trace contribution without repeating the fluctuation integral. The original negative difference is overwhelmingly a contact contribution through the witness geometry. The event-clock contribution is small and nonzero; the complete quantum-channel contribution is exactly zero.

The raw matrix derivatives retain the partition factor, current moments and Perron-vector derivatives. The gauge pullback also retains the contact term. The full 72 by 72 matrices and independent finite-difference checks are archived. The Doob laws give closed-cover durations 19.0175 and 19.7435 for the relaxed and locked parents under a stationary-sampled initial anchor. Each cover retains that anchor; this stated mixture is not an identification with a physical event-chain anchor law. Regrouping these histories does not add a force factor.

The colour, weak and hypercharge block trace changes are respectively -0.00125715, -0.000139130 and -0.000374482, on 48, 18 and 6 cycle-generator coordinates. They are not sector stiffnesses: the blocks are anisotropic on the fixed witness, and the colour–weak cross-block norm is 0.000268196. The

D41 bath has not been reprofiled on this extended transfer. This calculation establishes a nonzero energetic route into the gauge response under its explicit attachment; it does not select a row of Table 9 or replace the complete six-defect physical weighting.

13.6 Entropic balance and exposure

Each edge has 98 real current coordinates, so flat current measure has radial factor $r_e^{97}dr_e$. Ignoring the angular witness factor and setting $q_e = Q/12$ gives the equal-amplitude radial saddle

$$\begin{aligned} \frac{582}{Q} &= \beta\left[\frac{1}{2} + \frac{SQ}{144} + \frac{P(Q-Q_*)}{144}\,\mathbf{1}_{\mathrm{locked}}\right], \\ S &= \mathbf{1}^{\mathsf{T}}K_{\mathrm{rel}}\mathbf{1} = 354.10075, \quad P = \mathbf{1}^{\mathsf{T}}K_{\mathrm{pin}}\mathbf{1} = 217.82111. \end{aligned} \tag{62}$$

At unit exposure this gives $Q_f = 15.28303$ and $Q_l = 12.21941$, ratio 0.79954, close to the integrated ratio 0.79415. It explains the scale of the 20.6 per cent change by the dimension count and kernel sums. This saddle is a diagnostic, not an exact one-dimensional marginal: the coefficient 582 belongs to the radial-density convention; changing to q_e gives power 576 on an equal-profile slice, while the full total-intensity measure before shape integration has power 587. The calculation uses the exact measure and the angular factor throughout.

The witness enters the integral only through $b_e = \| j_e \|^2$, ranging from 1.96365 to 2.10988. Replacing these by their mean 2.05639 while retaining the distinct spoke and rim amplitudes gives the classical minimum 0.925390, close to 0.927124. Replacing all mean edge intensities by their common average gives the two smaller Perron roots in Table 19; their differences from the actual roots quantify the spoke–rim asymmetry. Neither a uniform-profile saddle nor a uniform-target control is the complete gauge response.

The exposure control multiplies the entire action by β, holding the flat measure, geometry and minimum-pinned record fixed. It changes no measured coupling and is not identified with a physical clock or a coarse-graining scale. Four scrambled rules of 32,768 points per parent give Table 21. The last column uses F/β to remove the trivial multiplication of a classical action by exposure.

Table 21. Exposure control for the minimum-pinned model. The reference static trace difference is 0.000400531.

Exposure β	**Relaxed mean intensity**	**Locked to relaxed intensity ratio**	$\Delta \mathrm{tr} H_g/\beta$
0.1	50.392278	0.785626	-0.000586725
1	15.859817	0.794146	-0.001770688
10	4.960922	0.820932	-0.004729263
100	1.676947	0.892586	-0.006570491
1000	1.010540	0.976668	-0.001176901
10000	0.935498	0.997388	0.000229768
100000	0.927960	0.999736	0.000383303

The 20.6 per cent intensity change and negative trace are not exposure-independent. The trace becomes positive between the tested exposures 10^3 and 10^4. The classical 82.15 per cent survival ratio is unchanged by multiplying both profiled costs by β; it is a statement about that minimum, not a universal fraction of the integrated response. At large β, Laplace concentration gives H_g/β tending to the profiled Hessian and the partition locking cost tending to the Gaussian determinant cost 0.486610. At $\beta = 10^5$ the

trace difference per exposure is 0.00038330 and the partition cost is 0.52451, approaching those limits. The matrix difference can still have both signs at finite exposure even when its trace is positive. Changed-proposal controls and raw-pressure finite differences are archived [22].

13.7 Locking realised configurations

Fact-Lock fixes the record of a realised event [19, Section 7]; it does not require the event to occur at a current-energy minimum. A separate test draws q_* from the relaxed unit-exposure law at $\theta = 0$ and subsequently holds each draw fixed. Its quenched response is

$$\overline{F}_l(\theta) = \mathbb{E}_{q_* \sim p_f(\cdot;0)} \left[-\log Z_l(\theta; q_*) - \log r \left(\widetilde{M}_l(\theta; q_*) \right) \right]. \quad (63)$$

The expectation is outside the logarithm. Differentiation acts on the conditional response, not on the fixed preparation law of the record. This tests equilibrium-drawn commitment. Section 13.9 evaluates the event-induced bias within this parent and includes preparation derivatives when the preparation varies with the probe.

The execution uses 4 independent outer rules, each with 1024 recorded configurations sampled from a 131,072-point relaxed importance rule, and 4,096 inner points per fixed record. The smaller 256-record execution and independent broader-proposal inner checks test convergence. Quoted errors in Table 22 are empirical standard errors across the outer rules, not certified bounds.

Table 22. Atypical minimum-pinned record compared with equilibrium-drawn fixed records at unit exposure. The relaxed mean intensity is 15.8597.

Quantity	Minimum pinned	Equilibrium drawn and quenched
Mean intensity ratio	0.794146	0.999821 ± 0.000107
Partition free-energy cost	125.36794	0.71679 ± 0.00388
Total free-energy cost including clock	125.56457	0.71703 ± 0.00384
Gauge-Hessian trace change	−0.00177076	$(-3.97 \pm 0.99) \times 10^{-6}$

The 32-record inner refinement shifts the mean gauge trace by -0.70×10^{-6}, alongside the quoted outer sampling uncertainty. The one-fifth suppression disappears when the record represents the fluctuating ensemble rather than its rare minimum. The residual gauge-trace shift is of order a few parts in a million and must be read with its sampling uncertainty and inner-refinement shift; the original sign and magnitude cannot be promoted to properties of Fact-Lock alone. The annealed quantity $-\log\mathbb{E}[\exp(-F_l)]$ is different from the quenched mean and is also archived, without substituting it for the frozen-record operation. This magnitude description is not an upper bound or a universal sign claim. The comparison identifies the distribution of realised commitments as a quantitatively consequential input to the force calculation.

13.8 Self overlap and spatial radius

The density functional in [19, Sections 2–3] includes self overlap. Its pair potential subtracts the isolated self energies because constituent source strengths are fixed there. Here the amplitudes q_e vary, so the diagonal terms are not constants and cannot be dropped by the same argument. The relaxed kernel has diagonal 8.185361 at every radius. At unit radius it exceeds every individual off-diagonal entry, whose maximum is 5.139120; the full off-diagonal sum also matters, as the entropy balance shows.

Removing the diagonal gives smallest eigenvalue -7.611855 at unit radius. Since intensities must be nonnegative, this signed-direction test alone would not prove instability. There is also an admissible two-edge witness: an off-diagonal entry is -0.223554, so equal nonnegative intensity on those two edges has quartic coefficient $q^{\mathsf{T}}K_{\mathrm{off}}q = -0.111777$ when the total is one. Scaling both intensities makes the action unbounded below without the self term. Thus stability of this variable-amplitude model does require self energy at the unit-radius setting. The nearest profile pairs lie in the repulsive core, but some farther pairs already reach the attractive range; the unit cell is not wholly outside that range.

Table 23 varies the wheel radius R at fixed width $s = 0.4$ and fixed kernel masses, recomputing the classical record minimum at each radius. Endpoint vectors and their gauge chart remain fixed. Each row is a finite geometry control with 32,768 integration points per parent; no physical radius is selected.

Table 23. Radius control with self energy retained. The locked ratio refers to the minimum-pinned ensemble at each radius.

Radius R	$\lambda_{\min}(K_{\mathrm{rel}})$	**Relaxed mean intensity**	**Locked to relaxed ratio**
0.5	0.005427	10.42924	0.835768
1	0.573506	15.85999	0.794145
2	5.854823	25.91252	0.778366
3	7.371747	30.29619	0.804716
4	7.626577	29.80796	0.839880

The full kernel is positive throughout this scan, while the response magnitude and suppression vary with the spatial attachment. Self-energy removal and a change in radius are distinct controls; neither changes the definition of the original executed model.

13.9 Event selected configurations and the next record

The first-record partition of [5, Section 1D] determines a distribution of configurations at a crossing once the scalar parent of Section 13.5 is specified [23]. Write its density as $p_b(q)$ and address matrix as $A_{xx} = T_{xx}$ and $A_{xy} = T_{xy}\langle q_e\rangle_b$ for a crossing along edge e. Let $Ar = \rho r$, $l^{\mathsf{T}}A = \rho l^{\mathsf{T}}$ and $l^{\mathsf{T}}r = 1$.

Proposition 17 (configuration law at a recorded crossing). On this stationary parent, put $c_e = l_x T_{xy} r_y + l_y T_{yx} r_x$ and $C = c^{\mathsf{T}}\langle q\rangle_b$. Then

$$p_{\mathrm{event}}(q) = p_b(q)\frac{c^{\mathsf{T}}q}{C}, \qquad \langle q\rangle_{\mathrm{event}} = \langle q\rangle_b + \frac{\mathrm{Cov}_b(q)c}{C}. \quad (64)$$

The crossing probability per primitive step is C/ρ.

Proof. The Doob transition is $A_{xy}r_y/(\rho r_x)$ and the stationary address law is $l_x r_x$. Resolving a crossing into its configuration gives intensity $p_b(q)l_x T_{xy} r_y q_e/\rho$. Summing both orientations and normalising gives the density; integration gives the covariance identity.

The total mean intensity changes from 15.86001281 to 15.87552181, about 0.098 per cent. The crossing probability is 0.85245468, giving 1.17308288 primitive steps per record. Reweighting the frozen-preparation experiment of Section 13.7 by this law gives locked-to-relaxed activity 1.000039 ± 0.000108. The law determines the configuration **at** an event; it does not prove that the finite ledger stores or pins every component of q_*.

Retain the pinning attachment for the next-record test. For each q_* define the locked raw transfer in the free Doob frame,

$$B(q_*, b) = \frac{Z_l(q_*,b)}{Z_f(b)\rho_f(b)}\,\mathrm{diag}\big(r_f\big)^{-1} A_l(q_*, b)\mathrm{diag}\big(r_f\big). \quad (65)$$

Nonnegative pinning makes this relative transfer sub-stochastic. Since only self transitions are unrecorded, the waiting sum from address y is $v_y = \sum_{z\neq y} B_{yz}\,/\big(1 - B_{yy}\big)$. Retain the first endpoint–configuration correlation with $u_y = p_b(q_*)r_y \sum_{x\neq y} l_x\, T_{xy} q^*_{xy}$. The executed functional is

$$F_{\mathrm{event}}(b) = -\log \frac{\int \sum_y u_y(q_*,b)v_y(q_*,b)\,dq_*}{\int \sum_y u_y(q_*,b)\,dq_*}. \quad (66)$$

Derivatives of preparation, Perron vectors, partition factors, locked moments and waiting denominators are all retained, together with both terms of the gauge pullback.

Table 24. Joint first-record calculation at unit exposure. Errors are empirical standard errors across four independent scrambled outer rules of 1024 configurations, with 4096 inner points per configuration.

Quantity	Result
Relative first-record free energy	0.773414 ± 0.001915
Total 72-direction Hessian trace	$(-6.1844 \pm 1.5637) \times 10^{-6}$
Colour block trace, 48 coordinates	$(-4.4115 \pm 1.1915) \times 10^{-6}$
Weak block trace, 18 coordinates	$(-1.0413 \pm 0.3062) \times 10^{-6}$
Hypercharge block trace, 6 coordinates	$(-0.7316 \pm 0.4311) \times 10^{-6}$

The contact trace is $-6.1841102 \times 10^{-6}$ and the F_{bb} pullback contributes -3.3305×10^{-10}. The matrix is indefinite; these traces are not sector stiffnesses or force-screening fractions. Event-selection weighting is determined within this parent, while its current measure, exposure, energy attachment and permanent-record identification remain premises.

14 Conditional spatial and temporal force response

14.1 The specified approximation

The total response can be calculated for an explicit model while distinguishing its premises from physical matching. The execution [24] uses the common-zero six-defect phase parent, the inherited chiral operator [25], charge traces $Z = (6,13/2,21/2)$ and Weyl traces $Z_F = (6,6,10)$, in conventional hypercharge. The traces are reconstructed from the archived generators. No measured coupling selects a coefficient of this model. The separate diagnostic matching in Sections 14.6–14.10 uses measured inputs as explicitly stated there.

Canonical relative weights $a = b = 12/31$ and $c = 21/124$ are inherited. Identifying the shared long-wavelength cost $a + b$ with the PCN unit is an explicit attachment, giving $a = b = 1/2$ and $c = 7/32$. Current and conservation weights are one. The phase coordinates have kinetic metric $\tau Z_A I$ in each sector; a common propagation-speed condition fixes τ below. The neutral completion coordinate is the inherited independent massive block on this branch.

The history potential is this positive quadratic parent. Radial nonlinear feedback, scalar loops, gauge and ghost loops, and the global chiral-measure phase are outside the calculation. Append-only normalised readout adds no force pinning the independent active polar phase and no additional outcome-dependent

influence on the next configuration transition. Its complete channel cancels from the unconditioned pressure by Proposition 15. This readout premise does not implement Section 13.9's selected-record pinning or radial raw-activity transfer. The two executions answer different questions and their numerical responses are not added.

14.2 Joint elimination and the kinetic condition

For a transverse mode put $\lambda = 4\sum_i \sin^2(p_i/2)$ and $\sigma = 4\sin^2(\omega/2)$, with lattice spacing and time step one. Before eliminating current and polar record, the three-coordinate precision is

$$H_3(\lambda) = \begin{pmatrix} a\lambda + w_J + c & w_J & -c \\ w_J & w_J & 0 \\ -c & 0 & b\lambda + c \end{pmatrix}. \quad (67)$$

Proposition 18 (joint quadratic field response). Adding $\tau\sigma I$ and eliminating the last two coordinates gives

$$K_0(\lambda, \sigma) = a\lambda + \tau\sigma + \frac{w_J\tau\sigma}{w_J+\tau\sigma} + \frac{c(b\lambda+\tau\sigma)}{c+b\lambda+\tau\sigma}. \quad (68)$$

At low momentum, $K_0 = (a + b)\lambda + 3\tau\sigma + O((\lambda + \sigma)^2)$.

Proof. The auxiliary block has diagonal entries $w_J + \tau\sigma$ and $b\lambda + c + \tau\sigma$. Its Schur complement gives the formula and expansion gives the stated coefficients. Computation independently checks it against the complete gauge-quotiented phase parent.

Matching the gauge speed to the inherited free fermion speed one gives $\tau = 1/3$ in this family. The tree inverse couplings are Z, hence $g^2 = (1/6,2/13,2/21)$ in the stipulated units. They are matching-scale coefficients. The controls $\tau = 1/6$ and $2/3$ give squared speeds 2 and $1/2$. Holding the polar phase fixed gives a transverse mass term $K_{\text{fixed}}(0,0) = c$; requiring it to move with the link gives the exact spatial coefficient $a + b$.

The static Schur response $K_0(\lambda, 0) = a\lambda + \frac{cb\lambda}{c+b\lambda}$ contains no τ. With the fermion operator and probe held fixed, the spatial boundary is therefore independent of this kinetic choice. The temporal boundary retains the $\tau = 1/3$ premise; the specified temporal fermion completion remains a separate assumption.

The Gaussian heat transfer retains the coupled time correlations. Their integrated covariance is H^{-1}, rather than the instantaneous covariance. Raw Perron weights and eliminated determinants are kept, with no Markov reset after projection.

14.3 Time dependent fermion response and total couplings

For the inherited spatial seed S, define $K_s = \gamma_4 S$, $A_s = \gamma_4 \sinh K_s$ and $C_s = [g(K_s) + \gamma_5 g(K_s)\gamma_5]/2$, where $g(K_s) = K_s/\sinh K_s$. A specified extension of the static temporal term is

$$X = A_s - I + 1/2\,(C_s W_4 + W_4 C_s) + 1/2\,\gamma_4\left(T_4 - T_4^{\dagger}\right), \qquad H = \gamma_5 X, \quad D = I + \gamma_5 \operatorname{sign} H. \quad (69)$$

It agrees with the inherited expression when C_s and W_4 commute and preserves covariance and γ_5-Hermiticity. These conditions do not uniquely select the extension; its choice is a premise fixed before the temporal results.

The one-Weyl magnitude action is $-1/2 \log|\det D|$. Its analytic Hessian retains two one-link vertices, the contact vertex, derivatives of both matrix functions and the overlap sign. Spatial and temporal probes are $A_y = \epsilon\cos(kz)$ and $A_y = \epsilon\cos(kt)$. Space is periodic, fermion time antiperiodic and $N_t = 2L$; $k = 2\pi m/L$ corresponds to temporal index $2m$.

Let Π_B and Π_E be curvatures normalised by half the four-volume. The total responses and finite-volume inverse couplings are

$$\begin{aligned} K_{B,A} &= Z_A K_0(\lambda,0) + Z_{F,A}\Pi_B, \quad \kappa_{B,A} = \frac{K_{B,A}}{K_0(\lambda,0)}, \\ K_{E,A} &= Z_A K_0(0,\lambda) + Z_{F,A}\Pi_E, \quad \kappa_{E,A} = \frac{K_{E,A}}{K_0(0,\lambda)}. \end{aligned} \tag{70}$$

The background-response scheme defines $g^2_{B,A} = 1/\kappa_{B,A}$ and $g^2_{E,A} = 1/\kappa_{E,A}$. Reciprocating the truncated precision does not add higher-loop physics.

Table 25. Conditional couplings on $112^3 \times 224$, $m = 4$, $k = \pi/14$. *Difference means* $|\kappa_E - \kappa_B|/[(\kappa_E + \kappa_B)/2]$.

Sector	Spatial g_B^2	Temporal g_E^2	Difference
Colour	0.166207	0.165584	0.3752%
Weak	0.153454	0.152924	0.3464%
Hypercharge	0.094988	0.094649	0.3574%

These are model couplings at the stated lattice scale and scheme, not measured couplings at the Z-boson mass. Both definitions are reported; no averaging or fit to a measured strength resolves their matching.

14.4 Index seven blocking

The connected star has offsets $\{0, \pm e_1, \pm e_2, \pm e_3\}$. Its coarse basis has rows $(1,1,-1)$, $(2,-1,0)$ and $(0,2,1)$, determinant -7, and aliases $p + 2\pi m(1,2,3)/7$. The link block map includes oriented paths and satisfies the commuting gradient identity. For retained map Q,

$$C_{\text{coarse}} = QH^{-1}Q^{\dagger}, \qquad K_{\text{coarse}} = C_{\text{coarse}}^{-1}. \tag{71}$$

An independent change of coordinates checks the Schur identity and complete determinant factorisation, including the coordinate Jacobian.

Table 26. Matter-inclusive one-block couplings at the original $L = 7$ *probe. Entries are transverse polarisations, not uncertainty intervals.*

Sector	First polarisation g^2	Second polarisation g^2
Colour	0.169456937	0.169453220
Weak	0.156220604	0.156217444
Hypercharge	0.096755400	0.096753380

All seven archived matter polarisations and Gaussian time correlations are included. The normalised inverse couplings differ from corresponding fine values by 2 to 4.5×10^{-5} fractionally. Blocking at a fixed probe and changing wavelength are distinct operations; Tables 25 and 26 use different wavelengths.

One, two and three successive blocks are also executed for the tree parent, covering 7, 49 and 343 sites. The massless Maxwell coefficient approaches one at low momentum; the smallest three-block probe gives 0.999998502. This multilevel result is a tree test. The complete matter-loop alias response is executed for one block only. A temporal probe at zero spatial momentum is exactly retained because the other six constant-mode star weights vanish.

14.5 Running and finite matching

At fixed mode number and aspect ratio, fit $\Pi/\hat{k}^2 = c_0 + s\log(1/k) + d_2\hat{k}^2$. The one-Weyl logarithmic coefficient is normalised so that $12\pi^2 s = 1$.

Table 27. Three-size logarithmic fits. Three points fix three parameters; there is no independent fit residual or statistical error estimate.

Boxes L and mode m	**Spatial $12\pi^2 s$**	**Temporal $12\pi^2 s$**
14, 28, 56; $m = 1$	0.991970	0.989873
28, 56, 112; $m = 2$	0.994938	0.991903

The calculations support nearly common logarithmic running. The Weyl traces assemble $b_F = (2/3)(6,6,10)$ at this order; this does not newly derive scalar or gauge–ghost contributions or certify the full continuum limit.

Finite normalisation is a separate test. On $L = 56$, the inherited operator gives $(\Pi_E - \Pi_B)/\hat{k}^2 = 0.003651440$, 0.004068783 and 0.008987859 at $k = \pi/7, \pi/14, \pi/28$. The matched Wilson-seed overlap control gives 0.0000232311, 0.000369075 and 0.005278686. The large lowest-mode volume effect appears in both, while their difference stays near 0.00371 per unit Weyl trace. Polynomial and two-mode linear diagnostics give 0.00371156 and 0.00371234. This supports an operator-specific finite anisotropic normalisation, without proving its infinite-volume limit.

The candidate electric stiffness offsets are $(0.022269, 0.022269, 0.037116)$. Cancelling them through the temporal metric alone would require approximate shifts $\delta\tau = (-0.0012372, -0.0011420, -0.0011783)$. These are diagnostic requirements; no parameter or coupling was changed after inspection. One common time rescaling cannot remove three unequal offsets relative to Z exactly within this truncation. Omitted interactions or another permitted temporal completion may change the matching.

Analytic curvatures agree with direct finite differences at $L = 7, 14$ to 1.04×10^{-10} or better. The pure temporal gauge control is about 1.5×10^{-10}; exact reflection-orbit quadrature agrees with full sums below 2×10^{-17} on the checked grids. The Wilson control has an independent determinant check. These establish numerical reproduction, not experimental precision. The result is a total conditional response and quantitative matching target. Its premises and approximation delimit its use; the presence of stated assumptions is not itself a failure of derivation.

14.6 Matching conventions and inherited transport

The matching calculation [26] uses the spatial and temporal inverse couplings of Table 25 separately. Write $A_i = 1/g_i^2$ in colour, weak and conventional-hypercharge order. Their numerical boundary values are $(6.01660209, 6.51660209, 10.52767015)$ and $(6.03921605, 6.53921605, 10.56536008)$. SGRI-1 supplies the frozen comparison at M_Z: $\alpha_s = 0.1180$, $\alpha^{-1} = 127.95$ and $\sin^2\theta_W = 0.23122$ [27]. The nominal $M_Z = 91.1876$ GeV converts logarithmic intervals into comparison scales. These are the inherited benchmark and conventions, not a fresh experimental fit.

The boundary has the common form $A_* = Z + \eta Z_F$, with $\eta_B = 0.0027670154$ for the spatial probe and $\eta_E \approx 0.006536008$ for the temporal probe, up to printed rounding. Its sector dependence is fixed by the charge and Weyl traces together with the inherited transport. No new independent sector pattern enters this quadratic comparison, which explains its proximity to the earlier SGRI weak-angle result.

The running coefficients are inherited from [27, 28]. In the order above, $b = (-7, -19/6, 41/6)$ and

$$\frac{dA_i}{d\ln\mu} = -\frac{b_i}{8\pi^2} - \frac{1}{128\pi^4}\sum_j \frac{B_{ij}}{A_j}, \qquad B = \begin{pmatrix} -26 & 9/2 & 11/6 \\ 12 & 35/6 & 3/2 \\ 44/3 & 9/2 & 199/18 \end{pmatrix}. \quad (72)$$

The one-loop census identity $b = -(11/3)(3,2,0) + (2/3)Z_F + (1/3)(0,1/2,1/2)$ is checked independently. Thus scalar and gauge–ghost contributions are included in transport, although their finite matching contributions have not been calculated here. The headline two-loop calculation retains the gauge–gauge terms, holds the massless Standard Model census fixed and omits running Yukawa couplings and thresholds.

The first test sets the finite conversion shift to zero: $A(\mu_*) = A_*$. This identifies the finite-box response with a continuum boundary provisionally. The second uses $A(\mu_*) = sA_*$ and determines s and μ_* from the electromagnetic and strong inputs, as in the earlier relative test. It does not use the weak angle as an input. The factor s multiplies the gauge-action stiffness, equivalently the inverse squared coupling, is inferred from measurements and does not redefine PCN or select a new source coefficient. These scales belong to the coarse-grained comparison; no physical energy is assigned to a primitive bit.

In the fixed-normalisation test, the strong measurement determines the comparison scale; electromagnetism and weak mixing are predictions. In the two-input test, the strong and electromagnetic measurements determine the scale and one common factor; weak mixing alone is withheld. No three independent sector factors are fitted. The representation traces and calculated model corrections are fixed before either comparison. These tests distinguish a conditional prediction of absolute strengths from a conditional prediction of one relation between them.

14.7 Absolute and relative matching results

With the model normalisation fixed, the strong input determines a formal transport interval and the other quantities are predictions of that diagnostic. Table 28 shows the gauge-only two-loop results.

Table 28. Fixed-normalisation matching with zero finite conversion shift. Only the strong benchmark is used to determine the interval.

Boundary	**Predicted** α^{-1}	**Predicted** $\sin^2\theta_W$
Spatial	249.87821	0.208705
Temporal	250.78560	0.208575
Frozen benchmark	127.95	0.23122

The electromagnetic strength is therefore about half the benchmark. Formal intervals inferred from the strong input correspond to approximately 8×10^{27} and 10^{28} GeV. They are diagnostic extrapolations beyond the physically admitted regime of this calculation, not predictions of a physical scale. The following result gives the failure of scale-only matching without relying on those extreme extrapolations.

Proposition 19 (scale-only matching obstruction). In the zero-finite-shift branch, neither Table 25 boundary can reproduce the electromagnetic benchmark by running down from any $\mu_* \geq M_Z$, at one loop or at gauge-only two loops with positive couplings.

Proof. Let $\mathcal{L} = \ln(\mu_*/M_Z) \geq 0$. At one loop,

$$A_2(M_Z) + A_Y(M_Z) = A_{2,*} + A_{Y,*} + \frac{11\mathcal{L}}{24\pi^2}. \quad (73)$$

Since $\alpha^{-1} = 4\pi(A_2 + A_Y)$, the spatial initial sum already gives 214.18464 at $\mathcal{L} = 0$, above 127.95; the temporal sum is larger. Along downward gauge-only two-loop evolution the derivative of the sum is

$$\frac{11}{24\pi^2} + \frac{(80/3)g_S^2 + (31/3)g^2 + (113/9)g'^2}{128\pi^4} > 0. \quad (74)$$

Both evolutions increase the electromagnetic inverse coupling, proving the assertion. This statement concerns the specified conversion and transport truncation.

The one-loop spatial strong and electromagnetic inputs separately require $\mathcal{L} = 60.25779$ and -147.77134, so cannot share a scale. Even at $\mathcal{L} = 0$ a net shift $\Delta A_2 + \Delta A_Y = -6.86233$ would be required. This is a target difference, not a calculated source correction.

Allowing the diagnostic common factor gives Table 29. The uncorrected spatial and temporal comparisons infer scales 6.764×10^{13} and 6.808×10^{13} GeV. The earlier tree result is reproduced independently. The new finite model corrections slightly worsen its weak-angle comparison rather than remove the discrepancy.

Table 29. Conditional gauge-only two-loop comparisons. Strong and electromagnetic inputs determine the common factor and scale; the weak angle is withheld. Deviation is signed relative to 0.23122. The last column is a separate strong-input-only test with s = 1. Finite-term and D41 rows are sensitivity controls as specified in Section 14.8.

Matching boundary	**Common factor** s	$\sin^2\theta_W$	**Deviation per cent**	**Fixed-normalisation** α^{-1}
Earlier tree baseline	0.521425	0.227333	−1.68	249.21
Spatial model	0.520057	0.227289	−1.70	249.88
Temporal model	0.518206	0.227230	−1.73	250.79
Spatial finite-term control	0.523550	0.227401	−1.65	248.18
Temporal finite-term control	0.521673	0.227341	−1.68	249.09
D41 full history + spatial fermion	0.556860	0.234301	+1.33	233.09
Observed efficient + spatial fermion	0.594066	0.241391	+4.40	218.24
Bath reprofiled + spatial fermion	0.605987	0.243662	+5.38	213.86

The approximate weak-angle agreement is a relative test using two measured inputs. It does not derive the approximately 0.52 common gauge-action stiffness multiplier. At the principal diagnostic scales, matching all three benchmark values without that multiplier would require sector shifts approximately $(-2.88758, -3.08751, -5.09267)$ spatially and $(-2.90961, -3.10987, -5.13093)$ temporally, about 47–49 per cent of the model boundary values. These are requirements for comparison, not values inserted into the source.

For the principal quadratic boundaries, the weak-angle discrepancies are approximately 0.00393 and 0.00399 in absolute value against the frozen benchmark. This is approximate numerical agreement, not established agreement at experimental precision. For context, the 2024 Particle Data Group review quotes 0.23129 ± 0.00004 for the weak angle at the Z mass in the modified minimal subtraction scheme [30]. That dated value illustrates the measurement precision; it does not replace the frozen SGRI benchmark used here. A quantitative compatibility test additionally requires a theoretical uncertainty assessment for omitted dynamics, finite-volume effects, temporal completion and observable conversion. The numerical integration tolerances and boundary-control ranges reported here do not provide that assessment.

14.8 Finite conversion and conditional participation controls

One continuum component of the conversion can be evaluated exactly. For one massless Weyl trace in the convention $S = (A/4)\int F^2$, the background two-point contribution is

$$P_{\overline{\mathrm{MS}}}(Q,\mu) = -\frac{1}{4\pi^2}\int_0^1 x\,(1-x)\ln\frac{Q^2x(1-x)}{\mu^2}\,dx = \frac{\ln(\mu/Q)}{12\pi^2} + \frac{5}{72\pi^2}. \quad (75)$$

The finite integral is independently checked as $\int_0^1 x\,(1-x)\ln[x(1-x)]\,dx = -5/18$. Thus $C_W = 5/(72\pi^2) = 0.0070361933$ and, at this fermion-loop order, a continuum momentum-subtraction coupling satisfies $A_{\overline{\mathrm{MS}}}(Q) = A_{\mathrm{MOM}}(Q) - Z_F C_W$. The ordinary QED finite term is also given in [29]; the Weyl magnitude has half the Dirac weight.

Applying this term alone to the native finite-box boundaries gives shifts $(-0.04221716, -0.04221716, -0.07036193)$ and the finite-term control rows of Table 29. Fixed-normalisation electromagnetic inverse couplings remain 248.18423 and 249.09163. The conversion improves the relative comparison slightly and does not repair the absolute mismatch. Its application here is a sensitivity control: the native finite-volume definition has not been proved equal to continuum momentum subtraction. Finite-volume and lattice corrections, gauge and scalar finite parts, thresholds and the full common-observable matching remain to be evaluated. The computed fermion determinant must not be added a second time as an independent correction.

Independent transport checks reproduce the original SGRI one-loop value 0.22442649 and gauge-only two-loop value 0.22733305. Forward integration agrees with inverse shooting under tighter tolerances. Available $L \geq 28$ boundary choices give two-input angles from 0.22709828 to 0.22738680; this is a diagnostic range, not an uncertainty interval or continuum limit. Constant top-Yukawa controls $y_t^2 = 0.5{,}1$ are also executed. At $y_t^2 = 1$, the spatial and temporal angles are 0.22737569 and 0.22731632. These controls do not replace running-Yukawa or threshold matching. Scaling only the tree term rather than the complete boundary likewise leaves the discrepancy.

The one-loop transverse direction $n = (466, -687{,}159)$ obeys $n \cdot Z = n \cdot b = 0$ and $n \cdot Z_F = 264$. The spatial model addition has positive $n \cdot \Delta A = 264(0.0027670154)$, whereas the benchmark requires the transverse value -58.51874294. Before the fitted common rescaling, the continuum fermion term shifts this direction by -1.85755503, helpful but small. Together with Proposition 19, this separates the outstanding relative correction from the much larger normalisation change. It does not constitute an exclusion theorem for omitted VERSF dynamics.

At fixed strong and electromagnetic inputs, put $Q = A_2 + A_Y = 127.95/(4\pi)$ and let w denote the weak-mixing value. Then $n \cdot A = 466A_s + (159 - 846w)Q$. One unit of transverse response changes the weak angle by −0.000116091. The projection is exactly invariant at one loop because $n \cdot b = 0$ (see Eq. (76) for the tree boundary); gauge-only two-loop running adds the finite drift shown in Table 30.

Table 30. Transverse accounting for the fitted spatial model at the frozen strong and electromagnetic inputs. The last row is the additional low-energy contribution required to reach the weak benchmark.

Contribution	Transverse value
Fitted boundary contribution	+0.37990
Gauge-only two-loop running to the Z mass	−25.03931
Result at the Z mass	−24.65941
Frozen benchmark	−58.51874

Contribution	Transverse value
Additional contribution required	−33.85933

For the earlier tree boundary the starting transverse projection is zero and the two-loop drift is −25.03688. This accounts for the increase from its one-loop weak-angle value 0.22442649 to 0.22733305. Across the spatial baseline and three D41 controls the drift ranges from −25.03931 to −25.14599; its weak boundary dependence is retained. A positive multiple of the Weyl-trace vector has positive transverse projection and cannot itself supply the required negative boundary correction. The continuum finite term contributes −1.85756 before common rescaling, which is small on this scale.

The conditional D41 rows of Table 29 replace the tree vector by each printed row of Table 9 and add the spatial fermion vector $\eta_B Z_F$. The same two-input fit then determines the common factor and comparison scale. These controls retain the multiplicative attachment and one-current-component reading of Section 8.2; they add neither the continuum finite term nor the Section 13 feedback. They do not derive a common evolving carrier or recompute the matter determinant after participation feedback.

The spatial baseline and full-history row bracket the weak benchmark. The observed-efficient and bath-reprofiled rows overshoot by 4.40 and 5.38 per cent. These restricted combinations therefore fail the withheld comparison. That result does not exclude retained-record weighting in a fuller physical model: additional source-derived contributions or a revised attachment could change it. Their fixed-normalisation electromagnetic inverse couplings remain 214–233, so none repairs the overall strength.

The continuous target uses $A_{*,A}(\varepsilon) = Z_A(1 - \varepsilon n_A/49) + \eta_B Z_{F,A}$, with participation ranks $(n_s, n_2, n_Y) = (36,26,47)$. Hence $n \cdot \Delta A = -1286.112245\varepsilon$. Refitting the common factor and scale at each value gives ε = 0.0486766 for the spatial probe, 0.0480077 without the fermion term and 0.0495878 for the temporal probe. At gauge-only two-loop order the spatial target is 57.7 per cent of the full-history value and gives colour, weak and hypercharge reductions of 3.576, 2.583 and 4.669 per cent.

The target depends strongly on the transport truncation. Repeating the spatial refit at one loop, with the same fermion term and frozen benchmarks, gives ε = 0.0821740, or 97.5 per cent of the full-history value, compared with 0.0486766 at gauge-only two loops. The change is due to the two-loop transverse drift quantified in Table 30, with the common factor and scale refitted in each case. Thus the roughly 60 per cent target is specific to gauge-only two-loop transport. Omitted Yukawa terms and thresholds can change it; the difference between these two truncations is a sensitivity diagnostic, not a theoretical error bound.

One-at-a-time input scans also set the useful precision of the target. Holding the other frozen benchmarks fixed and refitting at gauge-only two loops, α_s = 0.1171 and 0.1189 give ε = 0.045480 and 0.051809. This is approximately ±0.0032, or ±6.5 per cent, around the central target for a strong-input change of ±0.0009. Weak-mixing values 0.23118 and 0.23126 give ε = 0.048200 and 0.049153, a change of about ±0.00048. Electromagnetic inverse couplings 127.94 and 127.96 give ε = 0.048642 and 0.048712, about ±0.000035 with the same sign as the inverse-coupling change. These are separate sensitivity scans around the frozen benchmark, not a combined confidence interval or an assessment of omitted dynamics. The practical target is therefore ε ≈ 0.0487 at gauge-only two loops, with about ±0.003 from the stated strong-input scan, versus ε ≈ 0.082 at one loop. Additional printed digits support reproduction, not physical precision.

At the spatial target, the fitted common factor is 0.540688. The participation contribution to the unscaled transverse boundary is −62.60359; retaining the baseline factor and drift instead would require −65.10693. The refit is therefore part of the target calculation. With the normalisation fixed to one, the target boundary still gives electromagnetic inverse coupling 240.19, only 53.3 per cent of the measured electromagnetic strength. Participation can correct the relative comparison while leaving the absolute

discrepancy substantial; these requirements need not be dynamically independent in the complete source.

The three discrete D41 controls keep the weak angle withheld. Selecting the continuous ε target uses that third measurement, so the exact agreement at the target is not a prediction. A physical derivation must select its participation response before that comparison and must also account for the common normalisation. The stated targets apply to the specified conversion and transport truncation.

14.9 Exact doubling control

The proximity of the inferred factor to one half motivates a sharply specified control. Set $A(\mu_*) = A_*/2$ before matching, use only the strong measurement to determine μ_*, and predict the electromagnetic strength and weak angle. This doubles every starting g_i^2, preserves their starting ratios and leaves no fitted common factor. It is a declared hypothesis, not a factor derived from the source. The comparison retains the zero-finite-shift premise and the same transport and census as Table 28.

Table 31. Exact doubling of starting squared couplings at gauge-only two-loop order. Only the strong input determines the scale. The electromagnetic excess is $\alpha_{\mathrm{pred}}/\alpha_{\mathrm{bench}} - 1$, not an error in its inverse.

Boundary	**Predicted α^{-1}**	**Electromagnetic excess**	**Predicted $\sin^2\theta_W$**
Spatial	122.85166	4.1500%	0.228846
Temporal	123.30581	3.7664%	0.228643
Frozen benchmark	127.95	0	0.231220

The weak-angle deficits are 1.03 and 1.11 per cent. The inferred comparison scales are 1.751×10^{13} and 1.987×10^{13} GeV. Independent downward integration with a one-dimensional strong-input root reproduces the inverse-shooting results; the one-loop calculation is also checked against its closed form. Thus doubling removes most of the absolute mismatch but fails the simultaneous comparison. Its smaller weak-angle deficit than Table 29 is obtained while electromagnetism is wrong and is not an improvement of the two-input relation.

The uncorrected two-input rows of Table 29 instead require starting squared-coupling multipliers $1/s = 1.922865$ and 1.929736. The corresponding multipliers of g_i itself are $1/\sqrt{s} = 1.386674$ and 1.389149. These are inferred targets within the specified conversion. They are not source-selected values, error bars or universal constants. A physical explanation must determine both the overall size and the smaller sector discrepancy; the shorthand “a factor of two” is not an exact closure condition.

14.10 Normalisation and predictive content

The one-loop form makes the independent test explicit. With the calculated boundary held fixed, the low-energy coefficients obey $A_{\mathrm{low}} = sA_* + b\mathcal{L}/(8\pi^2)$. The strong and electromagnetic inputs give two linear equations for s and $\mathcal{L}$; their coefficient matrix is nonsingular for both tested boundaries. The weak equation then supplies one remaining comparison. Gauge-only two-loop shooting implements the same parameter count. For the principal quadratic boundaries, the near-match tests this fixed relationship. It preserves the earlier SGRI result through the explicit approximation; because it inherits the same census and transport, it is not a statistically independent confirmation of that earlier relation or a new derivation of the census.

For the earlier tree boundary $A_* = Z$, the identities $n \cdot Z = n \cdot b = 0$ give $n \cdot A(M_Z) = 0$ for every common factor and matching scale. Using the strong and electromagnetic inputs in the transverse identity of Section 14.8 gives the closed form

$$\sin^2\theta_W = \frac{159+466\alpha/\alpha_s}{846} = 0.22442649. \quad (76)$$

Here both couplings are evaluated at the Z mass. This is the earlier SGRI one-loop relation with the scale and common normalisation explicitly eliminated. Transverse boundary corrections and higher-order running change it as quantified in Section 14.8.

An exact change of coordinates cannot supply a physical doubling. For a positive quadratic physical block, the action and a source probe are $S(x) = x^{\mathsf{T}}Kx/2$ and $J^{\mathsf{T}}x$. Gaussian integration gives $\partial_J^2 \log Z = K^{-1}$. Under $x' = tx$, consistency requires $K' = K/t^2$ and $J' = J/t$, so $J'^{\mathsf{T}}K'^{-1}J' = J^{\mathsf{T}}K^{-1}J$. The measure Jacobian changes no source derivative. The factor one half in a quadratic action therefore does not halve its Hessian, and relabelling the field does not strengthen its physical exchange. The physical quotient is understood when gauge zero modes are present.

The existing exact results also constrain where a change can arise. Regrouping unchanged histories with elapsed duration retained preserves their pressure response (Proposition 8). Appending the complete passive recorder preserves the scalar pressure (Propositions 15–16). Neither operation supplies a missing factor of two. Section 14.1 instead makes a substantive unit attachment: the shared long-wavelength coefficient $a + b$ is set to one. That attachment and the finite observable conversion must be audited against the complete source, together with the omitted dynamical contributions. A genuine change in those quantities can alter the physical response; a change in notation alone cannot.

15 Consequences for the force-strength calculation

15.1 Contribution to the Standard Model derivation

The force-strength derivation must connect the programme's charge content and participation response to the response of physical fields after coarse graining. This paper starts from the inherited charge coefficients $(6,13/2,21/2)$, D41 history law and source event maps. Its contribution is to calculate their transmission through completion and recording. Proposition 8 closes the completion conversion: regrouping unchanged histories, with duration and the complete boundary carrier retained, cannot generate an additional sector correction or require a new conversion constant.

The observation calculation supplies a positive force-relevant result. Proposition 7 and Table 8 show that omitted waits preserve the participation matrix family while changing its coefficients and coupling the two current components. Reprofiling the observed bath adds a calculable rank-two change. Section 8.5 transmits both matrices through the inherited gauge-to-current map; the effects are not confined to an address-rate example. Table 9 gives the resulting distinct colour, weak and hypercharge coefficients under the stated multiplicative attachment and current-component reading. Their dependence on the retained observation and bath treatment is derived from the archived law, with no measured coupling used to select it. This establishes an explicit mechanism by which the response relevant to a proposed force calculation can change while preserving the participation pattern.

The native event calculation supplies another part of the connection. Sections 11–12 compose the inherited resolved birth and current-record maps, calculate their finite occurrence coefficient and all 72 cycle-link probability derivatives, and return the internal state and energy-change identity needed at the next event. These are available operations for constructing an interacting history. The probability-curvature sign test specifies why that history must still be connected to the source action before its response is read as a force strength.

Section 13 adds two executed connections. Repeated native recording carries gauge information in correlations of retained outcomes. The fact-momentum extension transmits a permanent record's energy cost through current relaxation, unresolved fluctuations and raw event probabilities to a full gauge-

response matrix. The first is an information calculation on the inherited operation; the second is an energy calculation under specified carrier and weighting attachments. The advance therefore includes a closed conversion, a state-returning event operation and an evaluated energetic contribution. It brings the programme beyond an inherited ratio or a conditional static attachment by computing what particular histories and observations do to that response. The unresolved physical selection is precise: which joint evolving transfer, retained observation and bath reduction the source realises. The calculations here provide the matrices and event outputs against which that selection can be tested; they do not identify a conditional row of Table 9 with a measured coupling.

Section 14 adds total finite-scale coefficients, rather than only an isolated correction. The coupled quadratic response survives index-seven blocking, and its temporal and spatial matter contributions exhibit near-common logarithmic running. A matched control quantifies the finite anisotropic normalisation. This is an executed approximation with stated unit and temporal premises. Its trace structures Z and Z_F do not introduce D41's nonlinear participation interaction, and its passive record does not supply the complete event feedback. Sections 14.6–14.10 additionally execute the comparison with the frozen measured benchmark. The zero-shift, fixed-normalisation branch fails by Proposition 19, while the two-input test retains a 1.70–1.73 per cent weak-angle deficit and requires a fitted common factor. A calculated continuum fermion finite part is too small to remove either mismatch. The exact-doubling control overpredicts electromagnetism by 3.77–4.15 per cent. These results distinguish preservation under blocking, a near-match of the relative relation and successful absolute matching.

15.2 The complete physical weighting

The history-measure source supplies an explicit construction rule for the complete physical weighting [3, Sections 56A.1–56A.5]. On its complete carrier the transfer is the operational heat evolution sandwiched between the two reference-potential factors. The persistent and unresolved blocks, their mutual coupling and the core response must be obtained from that same operator. Its full defect increments determine the score family. A wheel support factor or a polar frame alone may not replace the magnitude-bearing defect differential.

The controlling sources specify the substrate potential [6, Section 11], conditional upstream inputs [3, Section 56A.11], and the distinction between an executed recorder and its physical derivation and permanent absorption [5, Section 1D]. Probability and operational geometry constrain norms and relative probabilities under their stated premises [9–11]. The current-rigidity source additionally requires common-parent ancestry, identification of the physical current and marks, and a magnitude-bearing event law [8, Sections 24–27]. Proposition 11 supplies an explicit probability-level connection between inherited maps on a resolved-birth branch. Section 12 executes a complete finite channel using that connection, and evaluates its birth-path coefficient, cycling-link derivatives and the separate source-action normalisation. The native output-state formula and its internal-energy identity in Section 12.5 additionally specify what this operation passes forward. These results are available inputs, rather than outstanding repetitions of the terminal-probability calculation.

The source already supplies the fact-momentum and Fact-Lock feedback equations [19]. Section 13 evaluates their attachment to the current and native event transfer, retaining the current fluctuations and physical link derivatives of that model. Section 13.9 determines the event-selected distribution and first-record waiting weights for the stated radial transfer. Their selection by the complete physical source still concerns the common carrier, measure, exposure, rate law and remaining coupled dynamics. The record-energy penalty and terminal-probability map are established inputs to that calculation. The parent of Section 5 has supplied diffusion and quadratic weights, static fermion curvature, absent radial matter and decoupled completion. Section 14 evaluates a kinetic choice and temporal fermion extension, but retains the quadratic scope and factorised readout; the finite event of Section 12 is not thereby embedded into its

full dynamics. Combining the two by an additional tensor-product law, or replacing the action Hessian with the event-probability Hessian, would introduce an unproved attachment. The failed local attachment does not exclude coupled terms or nonlinear coarse graining on a source-selected background. A primitive coefficient need not itself be an observable force strength; the coarse-grained response must be evaluated with the source's physical weighting.

15.3 What the executed ledger locks

The frozen native instrument uses the current, link and incoming internal state. Its ordered alphabet does not retain the independent polar record phase y of the scalar parent. Locking this ledger therefore adds no hard constraint on that independent phase in the executed construction. This agrees with the distinction between a retained outcome and a polar-phase constraint in [1, Sections 18.11–18.13]. It does not imply that a parameter-dependent record likelihood has no field response.

For the inherited scalar mode of eigenvalue λ, the quadratic cost is $1/2\,[\lambda q^2 + (j+q)^2 + \lambda y^2 + (q-y)^2]$. Free relaxation of j and y gives $K_{\mathrm{free}} = \lambda + 1 - 1/(\lambda+1)$; holding $y = 0$ while relaxing j gives $K_{\mathrm{lock}} = \lambda + 1$. At $\lambda = 1$ these are $3/2$ and 2. The executed alphabet supplies no reason to impose the second constraint. The first is the model's unconstrained reference, not a derivation that the complete physical event has stiffness exactly $3/2$: coupling the likelihood and record backreaction to the evolving source can change the quadratic response without imposing a hard phase lock.

15.4 The native closed-cover bath test

The native test requires one joint transition, not an identification of terminal probabilities alone. Section 12 returns a single event from a fresh neutral input, including its output state and edge/type flags. The D41 law instead assigns an independent participation mark and real-fibre label at every primitive step, including holds. Section 8.3 shows why repeating the native event by preparing its input again would add a reset absent from the supplied native history. Its changed internal state also does not specify the next seven endpoint fields, independent current, polar record and completion variables. Section 13.1 constructs a repeated unresolved-current history with its state retained and tests the address-only bath; Section 13.5 evaluates a specified current-energy transfer. Neither identifies the independent real-fibre bath scores of D41 with the complete native physical history. The twelve archived bath insertions still require that same-carrier identification.

Once that joint transition and its bath scores are specified on the same carrier, the calculation is definite: retain the returned state at each boundary, add the cover mask, differentiate the unnormalised source transfer and its duration variable, and form the current/bath pressure blocks. The bath-profiled response is the current block minus its cross-block Schur term on the physical nuisance quotient. It must then be compared with the full matrices of Table 8, including the cross-component block, before the physical gauge pullback. A stochastic transition's total probability, identically one, is not the required unnormalised pressure.

Section 8.2 executes both orders of this observation/bath reduction for the complete archived 30-score marked law and carries their difference through the existing gauge chart. It does not execute a native closed-cover transfer by silently replacing its state-dependent histories with that marked law. The discriminator is therefore sharper than choosing between two numerical screening fractions: the source must identify the history observation, the treatment of its bath and the two-current-coordinate coupling. A common scalar clock conversion cannot remove their calculated differences.

15.5 The next source calculation

The completed results supply a definite starting point for the next calculation. The first task is to justify the Section 14.1 attachment of the shared long-wavelength coefficient to the established PCN action unit. This requires the complete physical response and the conversion to the same observable used for measurement. The action unit itself is not a new adjustable parameter. The source calculation should determine the coefficient associated with the primitive event, carry it through the same current, record, completion and matter reduction, and evaluate the same coarse-grained field observable used for matching. Any changed parent requires its Schur reduction, measure and matter contribution to be recomputed; a common correction cannot be assumed to preserve the relative relation until this is checked.

The calculation must retain the normalisation of the field and its physical source probe together. A proposed change in the quadratic coefficient must therefore be checked in the source-to-source response after eliminating the coupled current, record, completion and matter variables. Section 14.10 excludes obtaining a physical enhancement by rescaling the field while leaving its probe convention inconsistent. The calculated coefficient, its unit attachment and its observable conversion should be reported separately so that a change in one is not counted again in another.

The second closure loop is a specific candidate to test at this level. If it only changes the stopping rule or groups unchanged histories, Propositions 1 and 8 preserve the response per original duration. If it changes the retained state, the source weight or subsequent dynamics, its operation must enter the joint transfer before differentiation and coarse graining. The same calculation must then return the common strength and the sector corrections, with both traversals and their shared variables counted once. The present paper establishes this discriminator; it does not supply a dynamical derivation of an exact doubling.

The source-derived corrections must be specified before the measured comparison. Under the present transport, a common change near $s = 0.52$ would address the main shortfall but would still leave the weak-angle discrepancy. Table 31 shows why an exact half-stiffness argument alone is insufficient. The full physical conversion may change these targets. The acceptance test is a comparison of all three strengths under one stated prescription, with every measured calibration input identified. Any D41 participation term or record-feedback contribution used in that test must first be derived on the same evolving carrier and in the same observable convention as the quadratic response; the conditional sums tested in Section 14.8 do not supply that physical identification. An absolute-strength claim requires the common multiplier to be calculated before the measured strengths are used for comparison. This paper closes the executed conversion and matching questions for its specified models; it does not require resolving that further source calculation to report those results.

Section 14.8 now quantifies the relative target. Under its multiplicative attachment, spatial fermion term and gauge-only two-loop transport, the physical reduction would need to yield ε ≈ 0.0487, with common factor 0.54069 still to be explained. The input and transport sensitivities in Section 14.8 limit the precision of this target. An equivalent correction in another convention must reproduce the same source-to-source observable after conversion. This value is inferred from all three benchmark strengths and is not an additional free parameter to tune. A source calculation selecting a different participation response must calculate the compensating sector terms and absolute normalisation together.

16 Conclusion

Completed-event grouping preserves the inherited response when elapsed duration and the complete boundary carrier are retained. Both tested participation stopping rules satisfy this identity, including

after the archived gauge-current pullback. A new event unit cannot by itself supply a force correction. A physical selection, reset or backreaction must enter as a change of the source law.

Observation changes the result in a calculable way. Omitting waits preserves the D41 participation family while changing its coefficients and coupling the two current components; relaxing the bath after observation adds a rank-two subtraction. The conditional screening parameters are 0.084313, 0.158932 and 0.180902 for the full, observed and reprofiled histories. Table 9 states their force-attachment premises. Native quantum types do not identify the independently marked D41 law with the complete quantum history.

The birth–current–record calculation supplies a finite occurrence coefficient, all 72 gauge derivatives and an explicit returned state. Its energy identity specifies what can pass to the next event. The sign of the probability curvature and the state-level regularity control show why neither terminal probabilities nor their Hessian alone determine the physical force response. In the tested scalar transfer the complete native recorder cancels from the pressure. Its energetic influence therefore requires feedback represented in the evolving transfer.

The fact-momentum model makes such feedback executable. Minimum-pinned records suppress average current activity by 20.6 per cent, while equilibrium-drawn and event-selected records leave it nearly unchanged. Event selection determines the configuration distribution within the specified radial parent. Differentiating preparation, waiting and the next-record functional gives trace $(-6.184 \pm 1.564) \times 10^{-6}$. That trace is small and indefinite and is not a force coefficient. Recording probabilities cannot be treated as an unevaluated large correction within this model.

The separate quadratic field–current–record approximation gives total conditional coefficients in all three sectors. Their response survives index-seven blocking. Spatial and temporal matter contributions have normalised logarithmic fits 0.995 and 0.992, with a finite difference of 0.35–0.38 per cent in the larger-box coupling comparison. The model coefficients are fixed without selecting them from measured strengths.

Matching exposes two distinct discrepancies. With the model normalisation and zero finite conversion shift, electromagnetism is roughly half as strong as the frozen benchmark; changing the scale alone cannot repair it. Fitting the common factor and scale to the strong and electromagnetic inputs predicts weak mixing 0.22729 and 0.22723 against the withheld 0.23122. A partial continuum fermion conversion gives 0.22740 and 0.22734. The earlier relative near-match survives, but the required common multiplier is inferred from measurements. Exact doubling, tested without fitting that multiplier, makes electromagnetism 3.77–4.15 per cent too strong and leaves weak mixing 1.03–1.11 per cent low.

The conditional participation controls connect this relative discrepancy to Section 8. The full-history correction crosses the weak benchmark, while the retained-record readings overshoot further. At gauge-only two-loop order its multiplicative pattern requires $\varepsilon \approx 0.0487$ to match the benchmark, roughly 60 per cent of the full-history value. The target becomes about 0.0822 at one loop and moves by about ±0.0032 across the stated strong-input scan. Even at that target, fixed-normalisation electromagnetic inverse coupling remains 240.19. The paper therefore identifies a correction with the required sign and sufficient size, together with a quantitative target for its physical selection; the overall strength remains unexplained.

The advance is a reproducible passage from inherited charge and event data through completed histories, recording, conditional field response and a comparison with measurement. It includes exact preservation and cancellation results, explicit dynamical outputs and a quantified failure of absolute matching within the tested approximation. The remaining physical task is to determine the common normalisation and sector corrections from the complete source and a common-observable conversion. Their required size is now a testable target; neither an unexplained factor of two nor the fitted multiplier is a derivation of it.

Appendix A Reproduction and source provenance

The accompanying calculation archive contains the exact inherited transition matrix, stationary law, joint Gaussian parents, coarse map and native conditional score moments. It also includes the executable calculations, numerical results, manuscript source, source excerpts and a SHA-256 manifest. The native conditional marked moments are inherited inputs, not a fresh regeneration of the full marked instrument in this paper. Their archived generator is included for provenance, with its original dependencies identified.

The executable calculation packages are identified below. The five baseline scripts, calculate.py, native_information.py, verify_renewal.py, verify_compression.py and ledger_information.py, give 264 named checks of the cover law, Gaussian rewards, native readout, coupled-clock renewal and finite-path likelihoods. Independent direct time-pair covariance sums agree with the closed formula to 5.9×10^{-15} relative error.

d41_waiting.py reconstructs and profiles the marked score law, checks the geometric waiting marginal and calculates its six information fractions. ledger_symmetry.py checks the rank and dihedral decomposition of the original waiting loss. participation_record.py rebuilds the twelve native Kraus channels and checks the one-step incoming-mark refinement and post-record support. marked_completion.py constructs both five-mark stopping rules, retains source and duration derivatives, checks finite source tilts and pulls the response through the nonlinear gauge-current map. raw_pressure.py evaluates all three source-weight derivatives, their mixed Hessian, independent finite differences and the scalar phase controls. These five scripts add 347 named checks, giving 611 in total. Repeated per-edge support checks are numerical consistency checks, not separate physical results.

joint_source/src/derive_and_test.py reproduces Section 10 from the inherited current-map arrays and native instrument. Its 49 checks cover finite joint increments, first and second current derivatives, the failed attachment and its gauge-path limit, and the regular channel. Together with the 611 checks above, these give 660 named numerical checks. The detailed source register, input hashes and full numerical output are retained under joint_source/.

birth_current_connection/src/connect_birth_current.py reproduces Section 11. Its 531 checks cover the exact finite rim map, resolved-birth preservation, the conditional current-first law, gauge covariance, 80 seeded active rays and both explicit spatial bases. The largest absolute residual is 2.74×10^{-15}. These executions give 1191 named checks; repetitions verify identities and are not separate physical predictions. The neutral and charged-singlet zero-commutator cases retain the complementary channel. The source note, original extracts, freshly retrieved public papers and their hashes are included under birth_current_connection/.

full_event_response/src/calculate.py reproduces Section 12. Its 253 checks include the exact birth-path coefficient, all edge/type effects, the complete no-birth complement, 72-dimensional gauge Hessians, independent non-Abelian finite differences, gradient/cycle decomposition, the hazard chain rule, source-action reciprocity, PCN conversion and the fixed-address crossing effect. The largest absolute check residual is 1.83×10^{-10}. The subtotal through Section 12.4 is 1444 named checks. The detailed results, response matrices and focused source readings are retained under full_event_response/; no check is counted as a separate physical prediction.

record_state_response/src/calculate.py reproduces Sections 12.5–12.6. Its 911 checks compare the closed state formula with the inherited Kraus construction on 56 resolved rays, verify completeness, positivity, sector Casimirs, gauge covariance, conditional product-state multipliers and the Heisenberg energy identity, test the matrix-valued regularity witnesses at decreasing current amplitude, and return all 85 retained record/internal-state blocks on both finite spatial modes with changed links. The maximum residual is 3.11×10^{-15}. The subtotal through this state calculation is 2355 named checks.

Product rays, nonmaximal native activity and random Hermitian energy matrices are verification probes, not source-selected physical inputs. The source passages and focused corpus screen are retained with this execution.

crossing_d41_response/src/calculate.py reproduces the pointwise participation decomposition, the full cross-component block, the observed bath Schur reduction, its rank-two order correction and both gauge pullbacks. It also checks the coupon-collector and boundary-law formulae, mode-curvature identity, Q/E closed forms and the gauge-invariant family-energy control. Its 54 named checks give a subtotal of 2409. The largest check residual is 5.67×10^{-11} in an independent first-crossing finite difference; algebraic participation reconstructions are below 10^{-15}. Exact matrices and conditional coefficient readings are included. No measured force coefficient enters these calculations.

native_repeated_response/src/calculate.py reproduces Section 13.1 with 165 checks of retained-state propagation, pair-response derivatives, stationary marginals, neutral-reference leakage and the address-only bath control. fact_momentum_feedback/src/calculate.py, integrate.py and validate_integral.py reproduce Sections 13.2–13.5 with 52, 62 and 44 checks respectively. They include nonlinear current minima, lock ordering, contact terms, full current integrals, changed importance proposals, native-channel completeness, raw Perron derivatives and cover absorption. These nineteen scripts report 2732 checks; repeated consistency checks are not separate physical predictions. The full matrices, result files and source hashes are retained with each execution. No new page-by-page corpus audit is claimed: these extensions use focused readings of [2], [3], [5], [8] and [19].

feedback_controls/src/controls.py, diagnostics.py and validate.py reproduce the self-score identity, pair-information sector diagnostics, entropic balance, partition/clock and contact/quadratic splits, exposure and radius scans, and the quenched-record experiment [22]. All first and second scalar-current derivatives and geometric jets are supplied. Numerical checks include changed proposals, five-point derivatives of the raw integral before taking its Perron root, and a 32-record inner-integration refinement. The outer recording law is held fixed during differentiation; no commitment-hazard score is silently omitted from a claimed physical calculation. Per-run checks and empirical sampling errors are reported with each result rather than merged into the preceding check count.

The package joint_event_weighting/VERSF_Joint_Event_Calculation/ reproduces Section 13.9 [23]. It contains event-law and moment checks, preparation and waiting derivatives, four-scramble convergence outputs, the full gauge matrices and inherited radial-parent arrays. The quoted uncertainty is the empirical outer-rule standard error, not a bound on omitted physics.

The package three_stage_response/ reproduces Section 14 [24]. Its pre-calculation model and temporal-extension records distinguish inputs from added premises. src/joint_model.py checks Schur reduction, gauge nulls, kinetic controls, history covariance, determinant factorisation and blocking. src/analytic_response.py gives full and exact reflection-orbit momentum sums; src/fermion_response.py supplies direct determinant controls; src/analyse.py assembles couplings, fits and Wilson diagnostics. Response grids, original seven-alias matter arrays and census matrices are supplied. Repeated commuting-map checks are numerical consistency checks, not independent physical results.

The package matching_attempt/ reproduces the original quadratic matching and finite-conversion controls in Sections 14.6–14.10 [26]. src/match.py supplies the fixed-normalisation and two-input transport, 56 named numerical checks, the no-scale test and the boundary and Yukawa controls. src/finite_part_control.py evaluates the continuum Weyl finite integral independently and repeats the matching with that partial conversion. The script src/normalisation_control.py fixes the half-stiffness hypothesis before matching and reproduces Table 31 with 16 independent checks, including downward initial-value integration and a scalar strong-input root. The unchanged three-stage input, machine-

readable results, frozen benchmark, source extracts and SHA-256 hashes are supplied. Check counts establish reproduction and are not counts of independent physical predictions.

The additional participation comparisons are reproducible from the six-decimal coefficients printed in Table 9, the spatial Weyl coefficient 0.0027670154, and Eq. (72). For each boundary, integrate to the Z mass and solve the strong-input and electromagnetic-sum equations for the common factor and logarithmic interval; compute the weak angle only after this fit. For the last column of Table 29, fix the common factor to one and stop at the strong benchmark. For the continuous target, vary ε in the boundary specified in Section 14.8 and solve the weak-benchmark equation after each two-input refit. For the one-loop target, set the matrix B term in Eq. (72) to zero; for each input scan, vary only the named benchmark and repeat the full refit. The one-loop target also follows from a three-by-three linear solve for s, sε and the logarithmic interval. Independent fixed-step fourth-order and adaptive eighth-order integrations agree at the displayed precision for the original participation comparisons; upward adaptive integration from the benchmarks reproduces the central target and supplies the sensitivity scans. These controls use printed inputs and add no new full-source or corpus calculation to the archived packages.

The calculation archive identifies the inherited inputs and their hashes, including the marked D41 arrays, gauge-current chart, quantum instrument inputs and scalar-parent generator. Its source provenance distinguishes inherited data, the preparation refinement, the generating transfer used for cumulants and the calculations executed here. The native conditional marked moments used in Section 4.2 remain inherited inputs. No independently sampled mark reset is introduced into the native quantum history.

The source inventory was refreshed across eight public website categories on 1 November 2026. It contains 609 PDF URLs, including edition and URL duplicates: 608 text-bearing extractions were screened, and one image-only flowchart was inspected visually. The inventory covers 22,697 pages. Focused source readings and selected uploaded versions supplement the term screen; this is not a page-by-page verification of every proof. Per-file hashes, search families, counts and focused-reading scopes are recorded in the archive.

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