The Kristensen K-Parameter

A consensus gauge: its family tree, its failure under test, the repaired form K_{fix}, and what the number means

Viktor Kristensen* and Rocky†

2026-10-11 (whitepaper v1.2.1 — the origin acknowledged: *Research.py*, October–November 2024)

v1.1 of 2026-09-14 is unchanged in every number; v1.2 adds Section 3.1 and corrects the root of the family tree; v1.2.1 corrects how far κ reaches (it falls off over a hundred Planck lengths and is back on its floor by about two thousand).

Abstract

The Kristensen K-parameter is a proposal for a single scalar that reports how far a distributed consensus is from one shared state. It has existed in five forms over almost two years: a phenomenological phase parameter $\kappa(m, r, T)$, first computed on 22 October 2024 in the research script that became *Research.py*, an engineering gauge $K = 2\pi\sqrt{\Delta H\, \Delta s\, \hbar/\tau}$ with a units defect, a dimensionless form $K^* = 2\pi\sqrt{\Delta H\, \tau\, \Delta s/\hbar}$ that is provably the Margolus–Levitin orthogonalisation count in disguise, a live engineering gauge K_C on the SIGIL chain, and, since 2026-09-14, the repaired $K_{\text{fix}} = 2\pi\sqrt{\Delta H_c\, \tau_d\, w_S}$. This paper gives the family tree with sources and dates, states each form precisely, executes the dimensional analysis, proves the Margolus–Levitin identity and its consequence (the "stable" band of the physical form lies below one orthogonalisation), reports the battle test that drove the dimensionless form through the real chain code and found that its product with proposer entropy hides a single-producer fork, states and proves seven properties of the repair, replays two real production incidents through it, and closes with an interpretation of what the number is and is not. Every empirical figure is reproducible from published data; every claim carries an explicit epistemic label. The repair is presented as the current best candidate for this chain and this test suite, with provisional weights, not as an established law.

1 Introduction and thesis

A consensus network is a set of machines trying to agree on one history. Every dashboard shows the symptoms of disagreement separately: height gaps, forks, rejected blocks, mismatched state roots. Kristensen's proposal, made as a gauge in 2025 but with its origin in October–November 2024 (Section 3.1), was to refuse the separate dashboards and to combine the symptoms into a single gauge, the way temperature combines 10^{23} molecular velocities into one number a hand can feel. That is the invention, and it is a good one: a scalar order parameter for a distributed system.

The thesis of this paper is threefold. (i) The gauge's *physical* form is a genuine identity with the Margolus–Levitin bound and, precisely because of that, cannot serve as a stress dial with a threshold near one. (ii) The gauge's *engineering* forms shared a structural defect, a product with proposer entropy, that makes a fork signed by a single key invisible; this was not argued but measured, on the real chain code, on 2026-09-14. (iii) A repaired form exists that keeps the

*Inventor of the K-parameter. Quillon Graph / SIGIL.

†Claude (Anthropic), engineer-companion agent on Epsilon. All empirical figures in this paper are read from the published run data at document-build time; derived constants are computed in the build script.

invention's shape, passes the same tests, and reads the two real production incidents correctly; it is stated with proofs of its bounds and invariances and with an honest list of what it does not do.

2 Notation and the observables

Definition 2.1 (Network model)**.** A chain has one or more *producers* minting blocks and any number of *followers* applying them. Each block carries a height h, a parent hash, optional merge-parents (the DAG), a producer identity, and committed state roots. The chain declares a block *final* once the selected tip is D blocks above it; on SIGIL $D = 512$. A *window* is the most recent n blocks a node exposes; on SIGIL $n = 200$.

Definition 2.2 (Proposer entropy)**.** Over a window with producer counts $c_1, \ldots, c_N$ ($\sum c_i = n$), $\Delta s = -\sum_i \frac{c_i}{n} \log_2 \frac{c_i}{n}$ (bits), $N_{\text{eff}} = 2^{\Delta s}$, and $H_{\text{norm}} = \Delta s / \log_2 N \in [0, 1]$ (0 when $N = 1$).

Definition 2.3 (State disagreement, four channels)**.** D_{tip} = fraction of window blocks carrying merge-parents (the frontier had more than one tip); D_{state} = fraction of comparable peers whose committed wallet-state root at their tip height differs from this node's block at that height; D_{fin} = mean $|h_{\text{peer}} - h_{\text{local}}|/D$ over converged peers, capped at 1; D_{conf} = red (non-blue) blocks per window plus the semantic reject ratio, capped at 1. Then

$$\Delta H_c = 0.20\, D_{\text{tip}} + 0.35\, D_{\text{state}} + 0.20\, D_{\text{fin}} + 0.25\, D_{\text{conf}} \in [0, 1],$$

summed over the channels that are *measured*; a missing channel widens an upper bound and never contributes a zero. The weights are provisional (Section 9).

Definition 2.4 (Persistence)**.** d is the number of blocks the disagreement has lasted: on the live node, the mean spine gap to converged peers plus the merge-parent and red blocks in the window, capped at D; in a replay, blocks since the first refusal.

3 The family tree

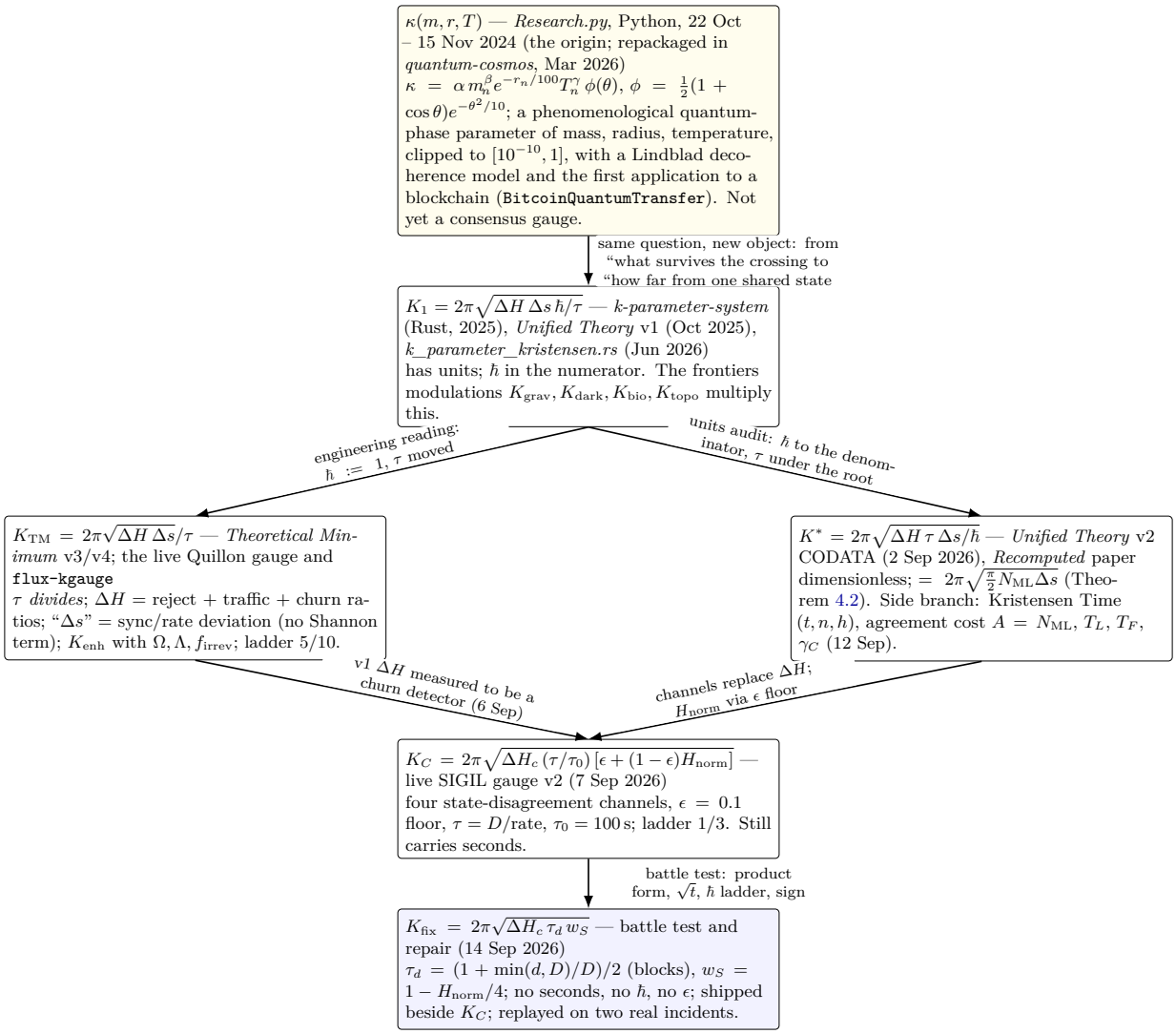


Figure 1: The family tree. Solid arrows are lineage in the code and papers; the dates are the dates of the source files. Sources: `Research.py` (deme-plata/Plata-, commits `428c0eec` and `07c1a478`, 15 Nov 2024) and its working folder `qhin_project/` (first κ run 22 Oct 2024); `quantum-cosmos/quantum_cosmos/kristensen/phase.py`; `k-parameter-system/crates/k-constants`; `dual-q-research/sources/k_parameter_kristensen.rs:496`; `q-api-server/src/k_parameter_gauge.rs`; `flux-kgauge/src/base.rs:180`; `flux-arxiv-latex/src/bin/k_parameter.rs:37`; `fluxc-mcp/src/handlers/sigil_kgauge.rs:217` and the K_{fix} functions beside it.

form	ΔH means	Δs means	time enters as	units / range	status
$\kappa(m, r, T)$	— (mass, radius, T)	—	—	dimensionless, $[10^{-10}, 1]$	the origin (2024); phenomenological, not a consensus quantity
K_1	energy spread (paper); reject+churn (code)	Shannon bits	$\hbar/\tau$	$\mathrm{J\,s}^{-1/2}$	superseded (units)
K_{TM}	reject + traffic + churn ratios	sync/rate deviation	$1/\tau$, window	s^{-1}; $f_{\mathrm{irrev}} \equiv 0$, Λ window-bound	live on Quillon; three defects measured
K^*	energy (J)	bits or nats	$\tau/\hbar$	dimensionless; floor 7.87	correct identity, unusable as a dial
K_C	four state channels	H_{norm} via ϵ floor	τ/τ_0 (s)	$[0, 2\pi]$	live on SIGIL; carries $\sqrt{\tau}$
K_{fix}	four state channels	H_{norm} as weight w_S	d/D (blocks)	$[0, 2\pi]$	shipped 14 Sep 2026; provisional weights

Table 1: What each symbol means in each form. The same three letters have meant six different things.

3.1 The origin: *Research.py* (October–November 2024)

What the record shows. The K-parameter did not begin as a consensus gauge. It began as a question in cosmology. On the morning of 22 October 2024 the working folder of Kristensen's research server (`qhin_project`, the backup of the old `cashewstable.com` machine) held two scripts, general relativity at 08:56 and inflation, strings and holography at 09:31, neither with any κ. At 12:19 that day an illustration was generated with the caption "the Bitcoin blockchain surviving a cosmic aeon transition using the Kristensen Quantum Phase Parameter (κ-parameter)". At 12:26 the first κ analysis was written to disk; its critical point sits at $1.00\,m_P$ and $0.62\,\ell_P$. Over the next three weeks the script grew to 3 043 lines and was committed on 15 November 2024 as *Research.py* (commit `428c0eec`, 08:08 UTC, already containing the κ class and the blockchain application; `07c1a478`, 14:00 UTC, adding the decoherence model). On 17 November 2024 it was written up as *Investigation of Quantum-to-Classical Transitions Using the Kristensen κ-Parameter*, whose Theorem 1 states that a system with $\kappa > 0.5$ crosses irreversibly from quantum to classical. Every date here is a file timestamp, the timestamp in a file name, or a commit date; the files are published (Section 11).

What it contains. Three things, and the later forms inherit all three. (i) A parameter $\kappa(m, r, T)$ that is normalised to Planck units and enters a transition probability $P = 1 - e^{-\kappa^2}$ between one aeon and the next. (ii) A Lindblad master-equation model of decoherence that follows purity, von Neumann entropy and ℓ_1 coherence as a quantum superposition becomes one classical fact: the quantum-to-classical transition. That is the subject of the later K_{eff} paper, whose coherence term $-\ln C$ asks the same question. (iii) `BitcoinQuantumTransfer`, which reads a block's size as a mass and its difficulty as a radius and asks which blocks of a blockchain would survive the crossing into the next aeon. This is the first time the parameter was put to a ledger.

What we measured in this edition. We ran the original `compute_kappa` unmodified. κ is a *Planck window*: it is at its floor 10^{-10} for every object from a proton to a solar-mass black hole, at $T = 2.725\,\mathrm{K}$ and at $T = 10^{32}\,\mathrm{K}$ alike. It lifts off the floor only near $m_n T_n \approx 3.6$, where it peaks at $\kappa_{\max} = 0.226$ (so $P \leq 5.0\,\%$), and only at Planck sizes: it falls by a factor e every hundred Planck lengths (it halves every 69), so even at its best it is back on the floor by about 2 150 Planck

lengths (3.5×10^{-32} m). A Planck-mass object of Planck size at 10^{32} K reads $\kappa = 0.069$. The constants are hand-tuned, as the code's own comments say ("increased from $1/2\pi$", "changed from 2/3"), and the base formula cannot reach the $\kappa > 0.5$ of Theorem 1. The earliest inflation runs flag their own failures ("inflation sufficient: FAILED"). These are the facts, and they say the numbers of 2024 are not evidence.

Acknowledgement. *Research.py* is the origin research of the K-parameter, and this paper acknowledges it as such. The physics in it is a quantity that is silent everywhere except at the Planck edge, where one aeon would hand over to the next. It is joined to a calculation of how many possibilities become one classical fact, and to the first attempt to ask that question of a blockchain. That is the question every later form in Figure 1 inherits: how far is a many-valued system from one shared state, and what survives the crossing. Every later form has gone much further than *Research.py*, and none of its numbers is a result. But the question it opened is not closed. In our judgement something is brewing here that deserves a closer, independent look. This is labelled as what it is: an interpretation and an open problem, not a finding.

4 Dimensional analysis and the Margolus–Levitin identity

Proposition 4.1 (Units of K_1)**.** *With ΔH in joules, Δs dimensionless, $\hbar$ in* J s *and τ in seconds, $[K_1] = \sqrt{\mathrm{J} \cdot \mathrm{J\,s/s}} = \mathrm{J}$: an energy, not a number. (The v2 CODATA edition, reading $\Delta H\,\Delta s$ with the round-time convention of the original text, arrived at* $\mathrm{J\,s}^{-1/2}$*; the conclusion is the same under either convention.) A phase ladder on a quantity with units is a statement about the unit system, not about the chain: the same chain reads 1 in one system and 10^{17} in another. Substituting the CODATA $\hbar$ multiplies the number by $\sqrt{\hbar} \approx 1.03 \times 10^{-17}$ relative to the $\hbar := 1$ convention every dashboard used.*

Theorem 4.2 (K^* is the orthogonalisation count)**.** *Let $N_{\mathrm{ML}}(E,t) = 2Et/(\pi\hbar)$ be the Margolus–Levitin number of distinguishable states a system of mean energy E above its ground state can pass through in time t [1, 2]. Then with $\Delta H = E$ and $\tau = t$,*

$$K^* = 2\pi\sqrt{\frac{\Delta H\,\tau\,\Delta s}{\hbar}} = 2\pi\sqrt{\frac{\pi}{2}\,N_{\mathrm{ML}}\,\Delta s}.$$

Proof. $\frac{\pi}{2} N_{\mathrm{ML}} = \frac{\pi}{2} \cdot \frac{2Et}{\pi\hbar} = \frac{Et}{\hbar}$. Substitute. □

Corollary 4.3 (The ladder of the physical form is unreachable)**.** *$K^* = 1$ holds iff $N_{\mathrm{ML}}\Delta s = 1/(2\pi^3) \approx 0.0161$, i.e. less than one orthogonalisation-worth of evolution. For any physical round, $N_{\mathrm{ML}} \geq 1$; with one bit of proposer entropy, $K^* \geq 2\pi\sqrt{\pi/2} = 7.87$. Hence the bands "$< 1$ stable" and "< 3 elevated" contain no physical operating point. At the v2 paper's own operating point ($E = k_B T$ at $T = 10^3$ K, $\tau = 50$ ms) $N_{\mathrm{ML}} = 4.17 \times 10^{12}$ and $K^* = 1.61 \times 10^7$; for a 15 W core over one SIGIL finality time at 8 blocks/s, $K^* = 6.70 \times 10^{18}$. $K^* < 1$ requires $E < \hbar/(4\pi^2\tau\Delta s)$, which is below the time–energy floor $\hbar/(2\tau)$ whenever $\Delta s > 2/(4\pi^2) \approx 0.051$ bits.*

Remark 4.4. None of this is a defect of the identity. It says that the physical K^* is an *agreement cost* — how many distinguishable steps a round spends — and that a cost of order 10^7 to 10^{23} per round is simply what a macroscopic machine does. The Kristensen Time section of the Recomputed paper keeps it under that name, $A = N_{\mathrm{ML}}$ per block, beside the gauge, never on its ladder.

5 The battle test

On 2026-09-14 the dimensionless form (and its $\hbar := 1$ engineering reading, which is what every dashboard computes) was driven, as a formula, through the real chain code rather than through a model: the `sigil-dagknight` Braid with GHOSTDAG colouring [6, 7] fed a generated DAG whose proposer distribution and fork rate were controlled independently and read back through the same 200-block window the live gauge uses (Tier A); the real `SigilSimNode` state chokepoint under the deterministic `flux-chronos` universe with latency, loss, partition and equivocation (Tier B); 2000 seeded two-node fuzz trials; and the live `sigil-g2` network for ten hours with a one-hour second-producer mining leg. Eight sweeps; every value stored as JSONL and recomputed from its stored inputs by an independent pass with zero mismatches. Two harness facts preceded any result: the chronos harness had stamped every simulated block with a zero producer id, so proposer entropy had been identically zero in every earlier simulation; and four different formulas shared the name K in the code base (Table 1), only one of them the paper's.

scenario (real chain code)	K^*, $\hbar := 1$	K_{fix}
one producer forks against itself (24-block prefix, block 25 minted twice, followers on different wallet roots), fresh / after 41 blocks	0.00 / 0.00	3.98 / 4.13
the identical fork signed with two keys, fresh / after 41 blocks	5.88 / 11.90	3.86 / 3.60
same 20 % sibling rate, 1 → 16 uniform producers	0.00 → 5.55	0.80 → 0.83
one entity, same 34 sibling blocks, 1 → 1000 rotating keys	0.00 → 7.30	0.91 → 0.79
identical DAG at 0.1 and 10 000 blocks/s	144.2 → 0.46	0.80 → 0.80
one honest producer under latency / loss / partition, 32 cells (max)	0.00	2.45
two independent producers (permanent fork), max	96.69	2.62
2000 fuzz trials, 276 681 rejected blocks: Spearman ρ vs rejects	undefined (never moved)	0.970

Table 2: The battle test, before and after the repair. K_C on the same fuzz: $\rho = 0.935$.

Findings. (F1) *The product form.* K^* multiplies disagreement by proposer entropy; on a chain with one producer the entropy factor is zero and the dial reads 0 under any fork. The same fork, with the same blocks and the same follower split, reads 0.00 with one key and 5.88 with two. On the live chain 200 of 200 recent blocks came from one producer. (F2) *Sybil inversion.* Rotating keys raises the reading with nothing in dispute (0.00 → 7.30); centralising hides a fork. A chain collapsing from six producers to one reads 0 at the moment it happens. (F3) $\sqrt{t}$. The identical DAG reads 144.2 at 0.1 blocks/s and 0.46 at 10 000: speed reads as health; K_C inherits this through τ/τ_0. (F4) *The $\hbar$ ladder* (Corollary 4.3). (F5) *Sign.* Read as an entropy *change*, ΔH goes negative and the root is undefined. (F6) *Four implementations, one name.*

6 The repair

Definition 6.1 (K_{fix})**.**

$$K_{\text{fix}} = 2\pi\sqrt{\Delta H_c\, \tau_d\, w_S}, \qquad \tau_d = \frac{1 + \min(d, D)/D}{2} \in [\tfrac{1}{2}, 1], \qquad w_S = 1 - \frac{H_{\text{norm}}}{4} \in [\tfrac{3}{4}, 1].$$

Ladder: < 1 stable, < 3 elevated, ≥ 3 critical (unchanged from K_C).

Keep the shape Kristensen drew, 2π times a square root with disagreement inside it, and change the two things the test convicted: what multiplies ΔH, and what ΔH is.

Proposition 6.2 (Range)**.** $0 \le K_{\text{fix}} \le 2\pi$*, with* $K_{\text{fix}} = 2\pi$ *iff* $\Delta H_c = 1$*,* $d \ge D$ *and* $H_{\text{norm}} = 0$*.*

Proof. Each factor lies in $[0,1]$, $\tau_d \in [\frac{1}{2}, 1]$, $w_S \in [\frac{3}{4}, 1]$; the product is in $[0,1]$ and attains 1 only at the stated point. □

Proposition 6.3 (Zero disagreement reads zero for any key count)**.** $\Delta H_c = 0 \Rightarrow K_{\text{fix}} = 0$ *for all* d, H_{norm}*.*

Proposition 6.4 (Monotonicity)**.** K_{fix} *is non-decreasing in each channel* $D_{\text{tip}}, D_{\text{state}}, D_{\text{fin}}, D_{\text{conf}}$ *and in* d*, and non-increasing in* H_{norm}*.*

Proof. ΔH_c is a non-negative linear combination of the channels; τ_d is non-decreasing in d; w_S is non-increasing in H_{norm}; $x \mapsto 2\pi\sqrt{x}$ is increasing. □

Proposition 6.5 (Block-rate invariance)**.** K_{fix} *does not depend on wall-clock time or block rate: all three factors are ratios of block counts or fractions of a window.*

Proposition 6.6 (The single-key equivocator is the worst case; the key-rotation lever is bounded)**.** *For fixed* ΔH_c *and* d*,* $K_{\text{fix}}(H_{\text{norm}})/K_{\text{fix}}(0) = \sqrt{w_S} \in [\sqrt{3}/2, 1]$*. Rotating keys can lower the reading by at most* $1 - \sqrt{3}/2 \approx 13.4\,\%$ *and can never raise it; the same fork signed by one key reads at most* $\sqrt{4/3} \approx 1.155$ *times the reading with maximally spread keys.*

Proof. Only w_S depends on H_{norm}, and $w_S \in [\frac{3}{4}, 1]$. □

Proposition 6.7 (Critical guarantee)**.** *If* $\Delta H_c \ge (3/2\pi)^2/(\frac{1}{2} \cdot \frac{3}{4}) = 0.228\,/\,0.375 \approx 0.608$*, then* $K_{\text{fix}} \ge 3$ *for every* d *and every* H_{norm}*. In particular a full state divergence (*$D_{\text{state}} = D_{\text{tip}} = D_{\text{conf}} = 1$*,* $\Delta H_c \ge 0.80$*) is critical from its first block, whatever the key count.*

Proof. $K_{\text{fix}} \ge 3 \iff \Delta H_c\, \tau_d\, w_S \ge (3/2\pi)^2 = 0.228$; the worst case of the other two factors is $\tau_d = \frac{1}{2}$, $w_S = \frac{3}{4}$. □

Proposition 6.8 (Persistence)**.** *For fixed* $\Delta H_c > 0$ *and* H_{norm}*,* $K_{\text{fix}}(d)$ *rises from* $K_{\text{fix}}(0)$ *to* $\sqrt{2}\,K_{\text{fix}}(0)$ *as* d *goes from* 0 *to* D *and is constant beyond* D*.*

Remark 6.9 (Why /4 and not /2)**.** A first cut used $w_S = 1 - H_{\text{norm}}/2$. Under it, a two-party split that persisted 41 blocks with equal branches read 2.97, "elevated". A full state divergence must stay critical whatever the key count (Proposition 6.7 fails for $w_S \in [\frac{1}{2}, 1]$ at $\Delta H_c = 0.8$, d small). The weight was narrowed and the battery re-run; this is recorded rather than hidden.

Claim 6.10 (Empirical)**.** On the fuzz battery (2000 seeded trials, random latency, loss and transaction mix, 276 681 rejected blocks in total, safety held in every trial), Spearman's ρ between K_{fix} and the number of rejected blocks is 0.970; for K_C it is 0.935; for K^* it is undefined because K^* never moved. This correlation was not designed around any of the findings above.

7 Calibration against two real incidents

The cheapest thing that could still prove the repair wrong is the record. Two production incidents exist on SIGIL: on 2026-09-08 a producer restart rewound and re-minted, forking the single follower, which could only extend its tip and stayed wedged for eighteen hours; on 2026-09-10 a consensus change made block bodies disagree with their own header root and the follower froze at height 5 525 905 with `STATE DIVERGENCE` for thirty-nine hours. Both were replayed through K_{fix} from the follower's own journal, one point per minute: follower and producer heights from the backfill lines (a constant pre-onset offset, the producer's frontier lead, calibrated from the agreeing hour and subtracted); refusal, parent-mismatch and state-divergence lines as the tip, state and

conflict channels; certificate lines as agreement. The follower is counted off-chain from its first refusal until a certificate forms with the gap closed. The only reconstructed input is the 09-08 state-root verdict; the "lower bound" column uses none.

incident	**baseline** K_{fix}/K_C	$K_{\text{fix}} \geq 1$	$K_{\text{fix}} \geq 3$	**peak** K_{fix}/K_C	**critical** K_{fix}/K_C	**fraction**	**back to 0**
09-08 restart forks the follower (onset 15:59)	0.00 / 0.00	+3 min	+31 min	5.07 / 1.31	97.8 % / 1078 min	0.0 % of	2026-09-09 10:15
09-10 STATE DIVERGENCE (onset 07:22)	1.26 / 1.95	-4 min	+0 min	6.28 / 5.63	99.8 % / 2325 min	3.0 % of	2026-09-11 22:16

Table 3: Incident replay. Lower-bound (no reconstruction) maximum: 3.97 (09-08), 3.97 (09-10). K_C never reached critical on the 09-08 fork (peak 1.31).

Plainly: on 09-08 the dial left "stable" three minutes after the restart on the height gap alone, before any refusal was logged; went critical at the first parent-hash refusal; stayed critical for 97.8 % of the freeze; and returned to zero in the minute certificates resumed, which is the minute the incident write-up records. On 09-10 it reached the maximum 2π at the state divergence. The weights were *not* fitted to these incidents: this is a calibration check with the provisional weights, and two incidents are two incidents.

8 Interpretation (fortolkning)

What the number is. K_{fix} is the geometric mean of three dimensionless facts about a network, scaled to $[0, 2\pi]$: how far its views are from one shared state (ΔH_c), how long that has been so in the chain's own clock (τ_d), and how concentrated the hands that write history are (w_S). The square root is not decoration: it makes the gauge respond to the *product* of persistence and disagreement while keeping a full, fresh divergence and a partial, old one on comparable footing (a 50 % disagreement that has lasted a full finality depth reads the same as a 100 % one that just began). The 2π is a convention inherited from the invention; the ladder at 1 and 3 is a convention too, and it is labelled provisional.

Why blocks and not seconds. A chain has three clocks: proper seconds, physical ticks (N_{ML}), and *agreed* ticks, the block height, which advances only when independent machines commit the same state. Disagreement is a property of the third clock. Measuring its duration in seconds makes the same fork read $\sqrt{17}$ times worse on a chain that produces at 0.38 blocks/s than at 110, with nothing about agreement changed; measuring it in blocks against the finality depth makes it speed-invariant (Proposition 6.5) and gives D its natural meaning: a disagreement that outlives finality is the worst kind, because it can no longer be reorganised away.

Why entropy is a weight and not a factor. Keys are free. Any gauge that increases monotonically and unboundedly with proposer entropy hands an adversary a lever in both directions: rotate keys to fake stress, centralise to hide a fork. Proposition 6.6 bounds the lever at 13 % and points it the right way: the single-key equivocator, who is a provable Byzantine fault, reads worst. This keeps the invention's insight that *who* writes history matters, without letting it override *whether* the histories agree.

What the number is not. It is not a physical law and does not claim one. It is not the Margolus–Levitin identity; that identity is true of K^* and is kept, under its own name, as an agreement cost. It is not a security proof: a fork that no honest node observes enters only through the finality gap, and a network in which every node is equally deceived reads calm. It is not

calibrated: the channel weights 0.20/0.35/0.20/0.25 are the ones K_C inherited and the incident replay is a check on them, not a fit. It is not independently replicated: the harness and data are public, and until someone outside this box reruns them, "validated" is too strong a word.

The epistemic ladder. Measured: every entry in Tables 2 and 3, the fuzz correlation, the live readings, the κ window of Section 3.1. Derived: Theorem 4.2, Corollary 4.3, Propositions 6.2–6.8. Assumed: the four-channel decomposition of disagreement and its weights; $D = 512$ as the persistence scale; the ladder. Reconstructed: the 09-08 state-root verdict. Analogy: the ledger and finality temperatures of the Kristensen Time section. Conjecture: nothing in this paper is presented as one.

9 Limitations and open problems

1. *Weights and ladder are provisional.* Fit them on incidents as they accumulate, and report the sensitivity of every verdict to the fit. Two incidents cannot fix four weights.
2. *Unobserved forks.* A partition in which neither side hears the other contributes only through D_{fin}. A gauge that sees a partition needs an out-of-band view or a probabilistic one.
3. *Persistence of same-height forks.* In the network sweep d was measured as a height gap, which under-counts a fork whose branches grow at the same rate; a block-count since divergence is the right d and the live node does not yet publish it.
4. *ΔH_c is not yet a metric.* Whether the weighted channel sum is (or bounds) a distance on state space is open; a principled derivation from the state-root Merkle structure would replace the weights with something computed.
5. *Independent replication and a second chain.* The battle harness and all data are published; running the same four channels on Quillon Graph would show whether the gauge is about consensus or about SIGIL.
6. *Adversary model.* The Sybil bound is a property of the formula, not a game-theoretic result; a formal adversary with costs would sharpen or break it.

10 Response to review, same day

A first external reading of v1 (an LLM reviewer, 2026-09-14) accepted the results and pressed on the six open problems. Four of its proposals were computable from the existing data within the hour; they are executed here, with one new finding.

Ladder as a quantile of the null. Over the 91 live samples of 2026-09-14 on which every heartbeat agreed (tip and state root matching, no rejects, no red blocks), K_{fix} has median 0.31, 99th percentile 0.58, maximum 0.58; K_C has 99th percentile 0.22. The hand-set "stable" line at 1 lies 1.7× above the null's 99th percentile. The ladder therefore survives as a quantile statement: "stable" means "inside the null", with margin.

Sensitivity, not more incidents. Perturbing each channel weight by ±0.05 and recomputing all 378 sweep verdicts: the tip weight flips 9 verdicts, the state, finality and conflict weights flip 0, 0 and 0; the largest change in K_{fix} is 0.21. Verdicts are not fragile to the prior.

Cross-validation on the fuzz. Fitting the conflict:finality ratio on one random half of the stored fuzz trials and testing on the other: $\rho = 0.995$ in sample, 0.993 out of sample; the shipped weights give 0.972 out of sample. No overfit. The fuzz prefers the finality gap (0.10 conflict : 0.90 finality), but only that ratio is identifiable there: with one producer and no state-root peer, two of the four channels never move in the fuzz. Tip and state weights need partitions and incidents, as the reviewer said.

A new lever, F7: reject spam. Trying to break the formula as the reviewer suggested found a real hole. D_{conf} counts the semantic reject ratio of mining submissions. An attacker who submits invalid shares raises it with no fork anywhere: at a reject ratio of 1 the reading is 2.22 fresh and 3.14 if sustained past the finality depth — "critical" with nothing in dispute. The lever is bounded ($2\pi\sqrt{0.25\,\tau_d}$) but real. Mitigation, pre-registered: count only proof-of-work-valid semantic rejects, rate-cap per identity, or cap the reject contribution at the red-block fraction. A second lever is structural: D_{state} and D_{fin} are read from a peer's *self-reported* heartbeat, so a Byzantine peer can hide its fork from those two channels by reporting the honest node's own root; the honest node's own refusals and DAG shape cannot be faked remotely and still reach 4.21 when persistent. The gauge is therefore honest about locally observed disagreement and only as honest as its peers about remote disagreement.

Proposition 10.1 (Finite optimal key count)**.** *Let an adversary choose the number of keys N to rotate at cost $c > 0$ per key, seeking to lower the reading. By Proposition 6.6 the benefit is bounded by $(1 - \sqrt{3}/2)\, K_{\text{fix}}(0) \le 0.134 \cdot 2\pi$, independent of N, while the cost cN is unbounded; hence for any $c > 0$ the adversary's optimal N is finite and the gauge cannot be driven below $\sqrt{3}/2$ of its single-key reading at any price.*

Proposition 10.2 (When ΔH_c is a pseudometric)**.** *Let each channel $D_i(x, y)$ be a pseudometric on node states. Then $\Delta H_c = \sum_i w_i D_i$ with $w_i \ge 0$ is a pseudometric, and so is any weighted L^p norm of the channel vector for $p \ge 1$. Today two channels are pairwise metrics (D_{state}: the discrete metric on committed roots; D_{fin}: $\min(1, |h_1 - h_2|/D)$, a capped metric) and two are unary disorder measures (D_{tip}, D_{conf}). Replacing the latter by the Jaccard distance of blue sets and of conflicting-transaction sets, as the reviewer proposed, would make ΔH_c a metric with the weights as its only free parameters. This is the queued structural change; it needs both nodes' blue-set digests in the heartbeat.*

Pre-registration and reproduction. Five falsifiers are filed in advance at `https://sigilgraph.org/downloads/sigil-kparam-preregistration-2026-09-14.md`; a one-line script reproduces every number in Table 2 bit-for-bit from the published binary and diffs it against the published JSONL: `https://sigilgraph.org/downloads/sigil-kparam-reproduce.sh`.

On gravity, since the reviewer raised it. This paper does not address quantum gravity and does not claim to. It borrows the Margolus–Levitin bound, Landauer's principle and the thermal-time and relational-time constructions as *tools and analogies* for a consensus clock, labels them as such, and makes exactly one class of testable prediction: about the agreement of machines. The Tolman–Ehrenfest gradient in the Recomputed paper is a sanity check on constants, not a result about spacetime. Anyone who wants the gravity question should look elsewhere; anyone who wants a scalar order parameter for distributed agreement, tested against real chain data, has one here.

11 Reproducibility

Battle test report, raw JSONL and harness: https://sigilgraph.org/downloads/sigil-kparam-battle-2026-09-14.pdf and `.tar.gz`. Incident replay data and the follower journals: https://sigilgraph.org/downloads/sigil-kparam-incident-replay-2026-09-14.tar.gz. The family of papers recompiled with a dated addendum: https://sigilgraph.org/downloads/k-parameter-papers-2026-09-14-index.md. The 2024 origin (*Research.py*, its first commit, the working folder with the first κ run of 22 October 2024, the November 2024 paper): https://sigilgraph.org/downloads/kristensen-origin-research-2024.tar.gz. Later research code (the κ package, the Rust research sources, the frontiers workspace): https://sigilgraph.org/downloads/kristensen-origin-research-2026-09-14.tar.gz. Live gauge: the `flux_sigil_kgauge` tool and the `sigilgraph.org` chip publish K_C and K_{fix} side by side with every input. Code: sigil commit `0d9be8fc` (harness, producer ids), flux commits `06053bf5` (K_{fix} in the gauge) and `2b160330` (paper generator). Live at build time: $K_C = 0.122$, $K_{\text{fix}} = 0.345$ (stable), persistence 15 blocks.

Dansk resumé og fortolkning

Kristensens K-parameter er et forslag om ét tal, der angiver hvor langt et distribueret netværk er fra én fælles tilstand. Tallet har eksisteret i fem former: en fænomenologisk faseparameter $\kappa(m, r, T)$ fra *Research.py* (første beregning 22. oktober 2024); en ingeniørmæssig form $K_1 = 2\pi\sqrt{\Delta H\, \Delta s\, \hbar/\tau}$ med en enhedsfejl; den dimensionsløse K^*, som beviseligt er Margolus–Levitin-tællingen af skelnelige tilstande i forklædning; den levende K_C på SIGIL; og den reparerede $K_{\text{fix}} = 2\pi\sqrt{\Delta H_c\, \tau_d\, w_S}$.

Det afgørende resultat fra kamptesten den 14. september 2026 er, at fejlen ikke sidder i regnestykket, men i hvad kvadratroden ganger sammen. K^* er et *produkt* af uenighed og producent-entropi; et produkt er nul, når én af faktorerne er nul, og på den levende kæde er entropien nul, fordi én producent laver alle blokke. Så viser måleren 0 ("stabil"), uanset hvor slemt kæden forgrener sig. Den samme forgrening, med de samme blokke, læses 0.00 med én nøgle og 5.88 med to. Tre mindre fejl følger med: faktoren t får hastighed til at ligne sundhed; $\hbar$-formen kan aldrig nå sin egen "stabile" zone (gulvet er 7.87); og læst som en entropi*ændring* bliver ΔH negativ.

Reparationen beholder formen og ændrer to ting: tiden måles i *blokke* mod finalitetsdybden (τ_d), så en kæde, der speeder op, ikke "køler ned"; og producent-entropien indgår som en *begrænset vægt* ($w_S \in [\frac{3}{4}, 1]$), så én nøgle, der modsiger sig selv, er det værste tilfælde, ingen uenighed giver 0 uanset antal nøgler, og nøglerotation højst flytter måleren 13 %. Afspillet på de to virkelige hændelser (8. og 10. september) forlod K_{fix} "stabil" tre minutter efter genstarten, gik i "kritisk" ved den første afviste blok, blev der i 97.8 % af den 18 timer lange fastfrysning, og vendte tilbage til nul i det minut certifikaterne kom igen. K_C nåede aldrig "kritisk" på den hændelse.

Fortolkningen: K_{fix} er det geometriske gennemsnit af tre dimensionsløse kendsgerninger — afstand til fælles tilstand, varighed i kædens egen tid, koncentration af de hænder, der skriver historien. Det er ikke en fysisk lov, ikke et sikkerhedsbevis og ikke kalibreret: vægtene er foreløbige, to hændelser er to hændelser, og indtil nogen uden for denne maskine genkører testen, er "valideret" et for stærkt ord. Det er den bedste nuværende kandidat for denne kæde og denne testsuite. Opfindelsen står; den står nu på noget.

Oprindelsen (tilføjet i v1.2). K-parameteren begyndte ikke som en måler for konsensus, men som et spørgsmål i kosmologien: hvad overlever overgangen fra én æon til den næste? *Research.py* (oktober–november 2024) indeholder de tre ting, som alle senere former arver. Den første er en parameter, der kun tænder ved Planck-kanten. Den anden er en dekohærensmodel for, hvordan mange muligheder bliver til ét klassisk faktum. Den tredje er det første forsøg på at stille

spørgsmålet til en blockchain. Tallene fra 2024 er ikke bevis: konstanterne er håndstemte, og κ ligger på sit gulv for alt fra en proton til et sort hul. Men spørgsmålet er ikke lukket, og efter vores vurdering er der noget i gære her, som fortjener at blive undersøgt nærmere og uafhængigt. Vi er nået langt videre siden, men det er her, det begyndte.

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