# TFPT — Red Team / Stress Test layer

Five adversarial targets (A–E): try to *break* the reductions, not confirm them

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**The TFPT document set — what is treated where**

**Plain language:** TFPT (Topological Fixed-Point Theory) is a small discrete compiler. Two inputs — the seam constant $c_3 = \frac{1}{8\pi}$ and the carrier rank $g_{\text{car}} = 5$ — build $D_5 \oplus A_3 + \mu_4 \Rightarrow E_8$ and read off the Standard-Model skeleton, the constants and the scale grammar. The series is **the introduction plus five numbered papers and three companions**, best read in order:

0. `introduction` — reading guide, compiler closure, predictions, the dependency DAG and the single proof ledger (`verification/status_ledger.csv`). *(entry point)*
1. `tfpt_1_architecture_e8` — the two axioms, the derivation map, the EM fixed point $\alpha^{-1}$, the $D_5 \oplus A_3 + \mu_4 \Rightarrow E_8$ construction, the QBL theorem chain.
2. `tfpt_2_standard_model` — the SM in one $\varphi_0$-ladder formula, flavor from parabolic transport (sheet diamond, dual anchor, $Q_+$ cohomology), the worked closures.
3. `tfpt_3_e8_audit_bootstrap` — the seven $E_8$ slices as an audit raster, the cascade bridge, the Möbius bootstrap.
4. `tfpt_4_frontier` — honest status of $\eta_B$, $m_p/m_e$, Koide, dark matter, full QG.
5. `tfpt_5_redteam` — the adversarial audit: declared attacks, what survives, what each reduces to, and the kill tests.

**Companions: R.** `tfpt_research_contracts` — the open interfaces ($v_{\text{geo}}, G_{\text{net}}, F_{\text{transfer}}$) as numbered contracts; **H.** `tfpt_horizon_readouts` — Appendix H (unit-system reframe): one seam constant as the universal horizon thermal code, the Nariai/anchor surface, the resummed seam clock; **O.** `origin_theory` — why no free fundamental number remains (exact core + one honestly-typed cyclic interpretation).

**You are reading document 5 (Red Team).**

**TFPT status at a glance — read this card the same way in every document**

**Two inputs, one compiler.** From the boundary constant $c_3 = \frac{1}{8\pi}$ (axiom P1) and the five-slot carrier $g_{\text{car}} = 5$ (axiom P2) — jointly the elementary symmetric data of one anchor $a = (1, 1, 2)$ — the discrete compiler $D_5 \oplus A_3 + \mu_4 \Rightarrow E_8$ is *built*, and the Standard-Model skeleton (gauge group, three families, hypercharges, the flavor matrix), the dimensionless constants ($\alpha^{-1} = 137.0359992$) and the scale grammar are read off as fixed points. The algebraic core is machine-checked; physical readouts run through *named bridges* whose status is typed below.

**What is closed, and what genuinely remains.** The discrete/algebraic layer is closed ([E]); the everything-open residual reduces to *three named interface problems*:

| Interface | Question | Status |
|---|---|---|
| $v_{\text{geo}}$ | the one dimensionful scale anchor (same nature as $1/G$) | reduced [O] |
| $G_{\text{net}}$ | the index-4 seam-net inclusion certifying the metric sector | open [C]/[O] |
| $F_{\text{transfer}}$ | source→pole / relic / cosmology transport (Koide, $\eta_B$, axion, $m_p/m_e$) | open [C] |

Everything carries a claim ID resolving to a row of `verification/status_ledger.csv` (the single source of truth); **if the text and the ledger ever disagree, the ledger wins.** The historical labels ($U_{\text{wall}}, G_{\text{metric}}, F_{\text{frontier}}$) are retained only for ledger continuity — the live residual is $v_{\text{geo}} \oplus G_{\text{net}} \oplus F_{\text{transfer}}$.

*Marker key: **[E]** exact / machine-proven · **[C]** conditional (holds under named hypotheses) · **[O]** open / axiom · **[X]** falsifiable kill test. Per-claim fine type in `verification/status_ledger.csv`.*

**[E]** exact / machine-proven **[C]** conditional **[O]** open / axiom **[X]** kill test

**P1** $c_3 = \frac{1}{8\pi}$ **P2** $g_{\rm car} = 5$ *(two inputs, [O] axioms)*

↓

Anchor $a = (1,1,2)$: $e_1, e_2, e_3 = 4, 5, 2$ *([E] exact)*

↓

Discrete compiler: $D_5 \oplus A_3 + \mu_4 \Rightarrow E_8$, $h = 30$, $\varphi_0$ *([E] exact)*

↓

SM skeleton: three families, hypercharges, flavor matrix $R$ *([E])*

↓

Physical bridges: $v_{\rm geo}$, $G_{\rm net}$, $F_{\rm transfer}$ *([C] bridges)*

↓

Frontier readouts: $\Lambda$, inflation, $\eta_B$, dark matter, QG *([C]/[O])*

**What this note is**

This is the deliberately *adversarial* layer requested in the v78 review. Its purpose is **not** to confirm TFPT but to attack the five load-bearing reductions at their weakest logical transitions. Each target is run through one fixed protocol — minimal statement, assumptions, logical chain, validity conditions, counterexample search, limiting/degenerate cases, alternative structures, provisional verdict — and produces a deliberately narrow output: where the statement works, where it could fail, and the residual risk. The layer is machine-backed by [`verification/redteam/rt_A_e8net.py`] … [`verification/redteam/rt_E_vgeo.py`] and [`verification/redteam/run_redteam.py`]; a red-team check asserts an *adversarial* fact (a counterexample really exists, a hidden assumption is really needed, a firewall really holds), and the honest outcome lives in the **status** of each target, never in a green pass.

| Target | Minimal claim | Status | Residual risk |
|---|---|---|---|
| A | seam–Calderón measure = $(E8)_1$ net | **reduced, not closed** | *one* statement: boundary-net holomorphy + $c$=8 ($\Leftrightarrow$ the index-4 inclusion); $E_8$ and bulk uniqueness then automatic (v83/v87/v89; Lie-level realisation v143). The three-residual form below is the historical development. |
| B | $g_{\rm car} = 5$ forced by the Pascal rule | **survives (narrowed)** | boundary derivation of half-spinor exhaustion (degree-2 truncation) |
| C | $k = c_3/2 = \frac{1}{16\pi}$, $S/A = \frac{1}{4}$ | **survives** | absolute $1/G$ (UV-sensitive) is the one anchor |
| D | ratios+products $\Rightarrow$ one scale $v_{\rm geo}$ | **survives (narrowed)** | CP phases ($\delta_{\rm CKM/PMNS}$) not covered by $v_{\rm geo}$ |
| E | one scale $v_{\rm geo}$ carries the theory | **survives (narrowed)** | EW/reheating/leptogenesis scales + seam=Planck identification |

# Method

The red team treats each reduction as a hostile witness. A confirmatory script that always passes is worthless here: the layer is built so that it *may* downgrade a claim. Three outcomes are allowed — **survives** (stands as worded), **survives (narrowed)** (stands only after a silent assumption is made explicit), and **reduced, not closed** (the conservative wording is the correct one). A fourth, **broken**, is reserved for an actual failure; none occurred.

## Target A — the $(E8)_1$ boundary-net identification

**Minimal claim.** The ambient metric/projective measure is reduced to identifying the seam–Calderón boundary measure with the $(E8)_1$ lattice net, carrier subnet $(D5)_1 \times (A3)_1$. [verification/redteam/rt_A_e8net.py]

**Logical chain (established).** The Sugawara level-1 central charges are $c(E8)_1 = \frac{248}{31} = 8$, $c(D5)_1 = 5 = g_{\mathrm{car}}$, $c(A3)_1 = 3 = N_{\mathrm{fam}}$, so the conformal-embedding criterion $c_{\mathrm{coset}} = c(E8) - c(D5) - c(A3) = 0$ holds [E]. This is *compatibility*.

**Where it breaks: central charge underdetermines the net**

Counterexample: $(D8)_1 = SO(16)_1$ also has $c = \frac{120}{15} = 8$, but is *not* holomorphic (four primaries $1, v, s, c$) — a distinct $c = 8$ net. Hence equal central charge is *necessary, not sufficient*: $(E8)_1$ is the unique *holomorphic* $c = 8$ net (even unimodular rank-8 lattice $= E8$), so **holomorphy (single vacuum sector, $\mu$-index 1) is the load-bearing extra assumption**. Dropping chirality is worse: the $c = 8$ Narain family is positive-dimensional. The constructive map seam–Calderón kernel $\to (E8)_1$ and the uniqueness of bulk reconstruction are not established; the gap $\Delta_{\mathrm{eff}} > 0$ *supports* tightness (clustering) but does not prove it.

**Verdict.** Keep "reduced to a rigorous boundary-net identification problem"; do *not* write "metric sector closed". The red team confirms the conservative wording. Status [C]. Residual: holomorphy proof + constructive boundary map + bulk-reconstruction uniqueness.

## Target B — carrier rank / the Pascal condition

**Minimal formal claim.** $2^g = g^2 + g + 2$ has the unique solution $g = 5$ (Lean-verified [E]). This arithmetic is *not* attacked. The attack is upstream: why must the carrier obey the Pascal half-spinor exhaustion $2^{g-1} = \binom{g}{0} + \binom{g}{1} + \binom{g}{2}$? [verification/redteam/rt_B_pascal.py]

**Where it narrows: the rule, not the arithmetic, selects 5**

Perturbing the constant breaks it: $2^g = g^2 + g + c$ gives $\{5\}$ only at $c = 2$; neighbours give other or empty solution sets. The truncation *degree* is the real choice: with $2^{g-1} = \sum_{k \le K} \binom{g}{k}$ one finds $K{=}0 \to g{=}1$, $K{=}1 \to 3$, $K{=}2 \to 5$, $K{=}3 \to 7$, i.e. $g = 2K + 1$. So choosing $K = 2$ (to reach $g_{\mathrm{car}} = 5$) is a physical postulate. It is corroborated — the $D5$ half-spinor $\dim S^+ = 2^{g-1} = 16 \Leftrightarrow g = 5$ and the family closure $N_{\mathrm{fam}} = (2^{g-1}-1)/g$, $g + N_{\mathrm{fam}} = 8$ both pick 5 — but each is itself a postulate, not a theorem.

**Verdict.** Theorem A's arithmetic core stands; the Pascal *selection* must be typed [O]/[C], not [E]. Residual: a boundary/seam derivation of half-spinor exhaustion.

## Target C — $k = c_3/2$ and the seam-area coefficient

**Minimal claim.** In reduced units $k = c_3/2 = \frac{1}{16\pi}$ and Fursaev–Solodukhin gives $S/A = \frac{1}{4}$. [verification/redteam/rt_C_kc3.py]

**The dimensional firewall holds**

The only legal chain is

$$k_{\mathrm{red}} = \frac{c_3}{2} = \frac{1}{16\pi} \text{ (dimensionless)}, \qquad k_{\mathrm{phys}} = \frac{k_{\mathrm{red}}}{G}, \qquad S = 4\pi\, k_{\mathrm{phys}} A_{\mathrm{phys}} = \frac{A_{\mathrm{phys}}}{4G}.$$

The forbidden form $k_{\mathrm{phys}} = c_3/2$ is dimensionally false (legal only at $G = 1$). A scan of `v67`/`v68`/`v73` finds every $c_3/2$ used as the *reduced* coefficient and **zero** naked dimensionful identities; the firewall's teeth are verified against a synthetic violation. Internally consistent with $1/G$ being UV-sensitive (Sakharov/Connes, v68).

**Verdict.** Safe as worded (reduced coefficient). Status [E] (structure) + [O] for the residual. Residual: the absolute $4D$ Newton scale $1/G$ ($\propto \Lambda^2 f_2$) stays the one dimensionful anchor; nothing *dimensionless* is open.

## Target D — $U_{\text{point}} \to v_{\text{geo}}$

**Minimal claim.** Ratios plus sector products determine the dimensionless amplitudes, leaving one common scale $v_{\text{geo}}$. [`verification/redteam/rt_D_upoint.py`]

**Where it narrows: the bijection needs explicit hypotheses**

For positive reals, (ratios, product) $\Leftrightarrow$ (individuals) is a bijection, and the TFPT sectors satisfy it (positive rational $c$, odd size $3 = N_{\text{fam}}$). But it *fails* off-assumption: even sector size leaves a sign ambiguity ($\{2, 3\}$ vs $\{-2, -3\}$ share ratio $3/2$ and product 6); complex amplitudes leave an $n$-th-root branch ambiguity ($\{1, 1, 1\}, \{\omega, \omega, \omega\}, \{\omega^2, \omega^2, \omega^2\}$ share all ratios and product 1); a zero amplitude is degenerate. **Genuine residual:** the bijection fixes amplitude *magnitudes* only — CP phases $\delta_{\text{CKM}}, \delta_{\text{PMNS}}$ are complex and are *not* folded into $v_{\text{geo}}$.

**Verdict.** Holds for TFPT once four hypotheses (real, positive, fixed branch, no zeros / odd sector size) are made explicit; they are silent in v75 and must be named. Status [E] (reduction) + [O] ($v_{\text{geo}}$). Residual: the CP-phase sector.

## Target E — $v_{\text{geo}}$ as the unique dimensional floor

**Minimal claim.** No pure-number theory can derive an absolute dimensionful scale; all scales are ratios to one unit $v_{\text{geo}}$. [`verification/redteam/rt_E_vgeo.py`]

**Single-scale audit: exact for the certified tiers, conditional beyond**

The closed compiler + protected IR readouts all reduce to (pure number)$\times v_{\text{geo}}$: $M_{\text{scal}} = c_3^{7/2} \bar{M}_{\text{Pl}}$, $f_a = (c_3/|\mu_4|)^{7/2} \bar{M}_{\text{Pl}}$, masses $= (\pi/\sqrt{2})\, c_f\, \varphi_0^k\, v_{\text{geo}}$, and $1/G$ shares the same anchor (v68/v75). The audit *surfaces* candidates that are not pure reductions: the seam cutoff $\Lambda$ (only an *identification* seam=Planck collapses it to $v_{\text{geo}}$), the electroweak matching scale, the reheating temperature, and the leptogenesis scale — all frontier [C]/[O] inputs that must not be silently absorbed into $v_{\text{geo}}$.

**Verdict.** $v_{\text{geo}}$ is the unique dimensional floor of the certified tiers (true by dimensional analysis). Full single-scale-ness is conditional on the flagged identifications staying honestly typed. Status [E] (ratios) + [O] (one scale). Residual: explicit reduction (or honest frontier typing) of the EW / reheating / leptogenesis scales + the seam=Planck cutoff.

## Outcome

**What the red team changed.** No target broke. The hardest gate (A) is confirmed *open* with the conservative wording; three targets (B, D, E) *survive once a silent assumption is named*; one (C) survives as worded. The net effect is not new physics but sharper typing: the package now states *where* each reduction would fail and *which* assumptions are truly necessary, exactly at the weakest logical transitions. Reproduce with `cd verification/redteam && python run_redteam.py`.

**Follow-up — the verdicts were then used as a worklist [E] ([`verification/v83_e8net_holomorphic_uniqueness.py`])**

Two residuals were attacked directly after the red-team pass; the result is recorded in ledger rows `GATE.METRIC.04` and `CAR.PASCAL.01`.

**Target A, residual 1 — closed [E].** At level 1 the number of primaries equals det(Cartan) = |fundamental group|: $A_3$=4, $D_5$=4, $D_8$=4, $\mathbf{E_8}$=**1**. So holomorphy (single vacuum sector, $\mu$-index 1) is *necessary* — it excludes the same-$c$ rival $(D_8)_1 = SO(16)_1$ ($c = 120/15 = 8$ but four primaries $1, v, s, c$) — *and sufficient*: a holomorphic $c = 8$ chiral CFT is the lattice theory of an even unimodular rank-8 lattice, of which there is exactly one, $E_8$, by the Minkowski–Siegel mass formula (mass $= 1/|W(E_8)| = 1/696729600$, and $|\mathrm{Aut}(E_8)|$ saturates it). The $(D_5)_1 \times (A_3)_1$ embedding $c = 5+3 = 8$ stays *compatibility* (16 primaries vs 1). **Consequence:** the constructive map need only show the seam–Calderón boundary net is holomorphic with $c = 8$ (then $E_8$ is automatic), so Target A drops from *three* residuals to *two*: (i) boundary-net holomorphy $+\,c = 8$ ($\Delta_{\rm eff} > 0$ supports, not proves), and (ii) bulk-reconstruction uniqueness — both still [C]/[O].

**Target B — reduced [E].** The "$K = 2$ Pascal truncation" is not free: $K = (g-1)/2$ is the Pascal-row midpoint $\sum_{k\le(g-1)/2}\binom{g}{k} = 2^{g-1}$ (odd $g$), i.e. the half-spinor split; the carrier is the even Clifford half-spinor $\Lambda^{\rm even}(\mathbb{C}^5) = 1 + 10 + 5 = 16 = \dim S^+$. So B's residual reduces to the single standard input "carrier = half-spinor of Spin(10)" (the Lean arithmetic core stays [E]).

Still open, typed honestly: A (i)+(ii); Target D's CP-phase residual (at $\theta_{13} = 0$ the Dirac phase is undefined, so this needs a texture correction); Target E's reheating/leptogenesis scales and the seam=Planck identification. Target C is a dimensional *floor*, not a gap. **No target was promoted.**

**Second follow-up round [E] ( [`verification/v87_bulk_uniqueness_reduction.py`], [`verification/v88_cp_phase_audit.py`], [`verification/v86_nstar_reheating.py`])**

**Target A, residual (ii) — conditionally closed [E]: Target A = ONE residual.** Bulk-reconstruction uniqueness is *not* independent of residual (i). By the algebraic-QFT classification of full 2D CFTs over a chiral net (Longo–Rehren; Kawahigashi–Longo–Müger; Bischoff–Kawahigashi–Longo–Rehren), the possible bulks are the haploid commutative Q-systems $\simeq$ physical modular invariants of Rep($A$). For a *holomorphic* net Rep($A$) = Vect, so the bulk pairing is *unique*. The contrast is machine-checked: the same-$c$ rival $SO(16)_1$ (discriminant category $\mathbb{Z}_2{\times}\mathbb{Z}_2$, $\mu$-index 4) admits *six* modular invariants — diagonal, $s{\leftrightarrow}c$ swap, both $E_8$-extension invariants $|\chi_0{+}\chi_{s/c}|^2$ (the lattice glue $E_8 = D_8 \cup (D_8{+}s)$, $h_s{=}1$ bosonic), and two twisted pairings — so without holomorphy the $c = 8$ bulk is *multiply* ambiguous; with it, trivially unique. Hence the entire Target A reduces to the single theorem "seam–Calderón boundary net is holomorphic with $c = 8$" ([C]/[O]; ledger `GATE.METRIC.05`). The theorem also has an equivalent, more tractable *index* form ( [`verification/v89_carrier_index_lemma.py`], ledger `GATE.METRIC.06`): by Kawahigashi–Longo–Müger, $\mu_A = [B{:}A]^2\mu_B$, the carrier inclusion has Jones index $[(E_8)_1 : (D_5)_1{\times}(A_3)_1] = \sqrt{16} = 4 = |\mu_4|$ — the glue-group order *is* the inclusion index — and the extension is the $\mu_4$ simple-current extension (all three glue sectors are $h = 1$ currents; $248 = 45{+}15{+}64{+}64{+}60$). Since an index-4 simple-current extension of the carrier has $\mu = 16/4^2 = 1$, **holomorphy follows from the index statement**: Target A $\Leftrightarrow$ "the seam net contains the carrier net with Jones index 4 as its $\mu_4$ simple-current extension" — both ends constructed objects, the index controllable by Longo theory, the gap supporting finiteness. And *which* extension carries no freedom ( [`verification/v92_glue_uniqueness.py`], ledger `GATE.METRIC.07`): exhaustive classification of the carrier discriminant form ($\mathbb{Z}_4{\times}\mathbb{Z}_4$, $q{=}(5x^2{+}3y^2)/8$) shows the extension tower is *completely rigid* — exactly two Lagrangian glues (the two chiralities, identified by the sheet $\mathbb{Z}_2$; the same two objects as the $E_8$-extension invariants above), and exactly one halfway extension, whose induced form $q = \{0, 0, 0, \frac{1}{2}\}$ *is* the $D_8$ discriminant form: the $SO(16)_1$ rival is the unique intermediate of the tower, not an arbitrary counter-model. Tower: carrier ($\mu{=}16$) $\to$ $SO(16)_1$ ($\mu{=}4$) $\to$ $(E_8)_1$ ($\mu{=}1$, sheet pair) — nothing else exists. Target A is thereby the *bare* index statement.

**Target D — the CP-phase residual quantified [E] (not closed).** With the frozen leading reading $\delta = \pi/3 + 3\lambda_C^2 = 68.65°$: pull vs $\gamma_{\rm PDG} = 65.7° \pm 3.0°$ is $+0.98\sigma$ (survives). Audit, *not* promoted: the data central value sits $0.07°$ from the alternative coefficient reading $\pi/3 + 2\lambda_C^2$ ($|\mathbb{Z}_2|$ instead of $N_{\rm fam}$) — a textbook look-elsewhere trap; the registry keeps coefficient 3 (`REG.FREEZE.01`). Decision threshold: the readings differ by $\lambda_C^2 = 2.88°$, i.e. $3\sigma$-distinguishable once $\sigma_\gamma \le 0.96°$. The $J$-inversion is flagged magnitude-contaminated (source-scale $s_{23}$ vs $M_Z$). Ledger `FLAV.CP.01`.

**Target E — one flagged scale computed [C].** The reheating temperature is no longer a silent input: $M_{\rm scal} = c_3^{7/2}\bar{M}_{\rm Pl}$ [E] + standard physics give $T_{\rm reh} = 9.6 \times 10^9$ GeV and $N_\star(0.05/{\rm Mpc}) = 51.4$ [C] (ledger `COSMO.NSTAR.01`); honestly recorded: this slow Higgs-channel point is $A_s$*-disfavoured* ($-11.4\sigma$; the measured $A_s$ requires near-instantaneous reheating), so the point is conditional on the decay channel and the frozen band $[50, 60]$ stays the surface of record; the leptogenesis scale and the seam=Planck identification remain typed inputs. **Again: no target was promoted; one residual was *merged* (A), one was *quantified* (D), one input was *computed* (E).**

**Global look-elsewhere closure [E] ([verification/v100_numerology_null_mc.py])**

The per-target look-elsewhere traps recorded above (the $\pi/3 + 2\lambda_C^2$ alternative in Target D, the ln(46080) scale reading destroyed in [verification/v99_koide_flow_time.py]) are local instances of the global adversarial question: *could the whole scorecard be formula-fishing?* The numerology null test answers it with an explicit, declared null model run in adversarial mode: the *entire* complexity-matched formula grammar (which provably contains every scored TFPT formula — the null space includes the theory) is enumerated against conservative data windows. Joint formula-fishing probability $\prod_i p_i = 10^{-25.8}$ over the 13 scored observables; all 94 500 $F_{U(1)}$ variants solved, exactly one hits CODATA ($p_\alpha \leq 1.1\cdot10^{-5}$); total $\leq 10^{-30.7}$. The test is falsifiable in both directions: the negative controls (seed perturbation 1%/10% collapses TFPT's own hit count 13 → 9/6; data shuffling → 1.2) prove it has power, and the census is stable under budget/window variation ($< 2$ orders). Honest limit, stated as such everywhere: this is a null-model rejection *conditional on the declared grammar* — no statistical test certifies a theory; the tension observables keep their large windows and contribute nothing to the number. Details and the grammar definition: the audit note (`tfpt_3`) and the module docstring.