

Global Validation of Matrix Node Theory / Evans Node Dialect: Status of the 50-Test Alignment Suite

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Abstract

Matrix Node Theory / Evans Node Dialect (MNT/END) models reality as an ordered sequence of discrete frames on a node lattice subject to a global limit on allowed change per progression step. Familiar continuum concepts—spacetime geometry, matter fields, and coupling constants—are emergent collective features of this constrained dynamics.

This report assembles and organizes the 50-test validation and reproducibility suite defined in the MNT/END documentation. Using only structures, definitions, and relations explicitly contained in the six core manuscripts, and calibrating to standard reference data (CODATA-style constants, PDG-style particle properties, gravitational-wave and equivalence-principle bounds, and standard cosmology), we:

- (a) identify which tests admit concrete numerical implementation with the current documentation,
- (b) carry out those numerical comparisons where possible, with residuals and indicative pulls, and
- (c) classify the remaining tests as conceptual or partially specified.

Given the present level of detail in the source manuscripts, only a subset of tests—notably those involving the invariant speed c , the low-energy fine-structure constant α , and basic gravitational invariants—can be implemented numerically without introducing new assumptions beyond the written theory. The rest of the suite remains at the level of structural alignment and qualitative consistency. We close with a roadmap for turning these conceptual tests into hardened numerical checks suitable for a full global fit.

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1 Introduction

1.1 Scope

The goal of this document is to provide a *global validation snapshot* for MNT/END based strictly on the internal corpus:

- **MNT_Axioms_Ontology**: ontological foundations and pre-geometric layer.
- **MNT_Math_Lexicon**: formal definitions and mapping between discrete and continuum descriptions.
- **MNT_Structural_Proofs**: derivation-style arguments for key structures (invariant speed, emergent fields, etc.).
- **MNT_END_COMPANION**: physical interpretation of the Evans Node Dialect as a concrete realization of the ontology.
- **MNT_Global_Validation**: catalogue of tests (T1–T50) and the intended validation strategy.
- **Global Alignment Summary**: overview of how these tests fit together and which sectors they probe.

The central question is not “Is MNT/END true?” in a philosophical sense, but the more practical: given only what is written in these documents, *how far can we get in confronting the theory with quantitative data?*

1.2 Philosophy of the Validation

Two methodological choices are important:

1. No new physics assumptions.

We restrict ourselves to structures, equations, and parameter relations explicitly contained in the six manuscripts. Where a derivation is only sketched qualitatively, we do not invent missing terms to force a numerical prediction.

2. Calibration vs. prediction.

Some observables (e.g. the low-energy value of α) are used in the text as calibration points: they fix combinations of emergent constants such as $\hbar_{\text{eff}}$ and the invariant speed c_{MNT} . Those tests are necessary internal consistency checks but do not yield non-trivial numerical predictions. We keep this distinction explicit.

The outcome is *not* a full multi-parameter global fit. Instead, it is a structured inventory of:

- which tests can already be implemented numerically with the current documents,
- which are conceptually well-posed but under-specified for numerics,
- and what additional derivations or parameter fixing would be required to promote each to a quantitative check.

1.3 Reference Data and Notation

Where numerical comparisons are possible, we use representative reference values:

$$c_{\text{exp}} = 299\,792\,458 \text{ m s}^{-1} \quad (\text{exact by SI definition}), \quad (1)$$

$$\hbar_{\text{exp}} \approx 1.054\,571\,817 \times 10^{-34} \text{ J s}, \quad (2)$$

$$G_{\text{exp}} \approx 6.67430 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}, \quad (3)$$

$$\alpha_{\text{exp}}^{-1} \approx 137.035999084, \quad (4)$$

$$M_{\text{Pl}}^{(\text{exp})} \approx 2.17643 \times 10^{-8} \text{ kg} \approx 1.22089 \times 10^{19} \text{ GeV}/c^2. \quad (5)$$

When needed, we adopt indicative uncertainties:

- For the speed of gravitational waves, a GW170817-like constraint

$$\left| \frac{v_g - c}{c} \right| \lesssim 10^{-15}$$

is taken as a rough 1σ bound.

- For equivalence principle tests, an Eötvös parameter

$$\eta_{AB}^{(\text{exp})} = 0 \pm 2 \times 10^{-13}$$

is used, consistent with MICROSCOPE-level measurements.

We denote:

- c_{MNT} : emergent invariant speed in MNT/END.
- $\hbar_{\text{eff}}$: emergent quantum of action in the MNT/END lexicon.
- G_{eff} : emergent long-wavelength gravitational coupling.
- $M_\star$: fundamental lattice/limit scale in the MNT/END construction.

Throughout, “prediction” means a value or functional form obtained from the MNT/END structure without inserting the experimental number by hand; “calibration” means a relation used to *fix* a combination of emergent constants to data.

2 Summary of the 50-Test Catalogue

The **MNT_Global_Validation** manuscript and the **Global Alignment Summary** describe a structured set of tests, labeled T1–T50. They can be grouped, very schematically, as:

- T1–T4: invariant speed, fine-structure constant, Planck scale, and running of α .
- T5–T12: charged-lepton and Higgs sector, weak interactions, neutrino properties, and dark-sector couplings.
- T13–T25: gravitational waves, equivalence principle, post-Newtonian and cosmological behavior.
- T26–T40: collider observables, cross sections, and cross-sector sum rules.
- T41–T48: large-scale cosmology, vacuum structure, and late-time acceleration.
- T49–T50: numerical reproducibility, algorithmic closure, and absence of hidden knobs.

In what follows we focus on those tests where the uploaded manuscripts provide enough explicit structure to do something quantitative, starting with T1.

3 Implemented Tests

3.1 T1: Invariant Speed and Gravitational-Wave Propagation

Statement of the Test

Test T1, as framed in the validation documents, asks whether the invariant speed emerging from the MNT/END node progression matches the invariant speed inferred from:

- special-relativistic kinematics of particles and fields,
- electromagnetic wave propagation,
- and gravitational-wave propagation from compact-binary mergers.

In particular, it focuses on the near-simultaneous arrival of gravitational waves and gamma-ray bursts (as in GW170817/GRB 170817A) to constrain any difference between the emergent gravitational-wave speed v_g and the electromagnetic speed c .

MNT/END Prediction

From the standpoint of MNT/END:

- The discrete progression with bound on allowed change per step gives rise, in the continuum limit, to an emergent invariant speed c_{MNT} .
- Both the electromagnetic and gravitational sectors are built on the same underlying progression, so their characteristic propagation speeds coincide at leading order:

$$v_{\text{EM}} = v_g = c_{\text{MNT}}. \quad (6)$$

The manuscripts do not introduce any mechanism that would split v_g from v_{EM} at observable levels in the current universe. Thus, the leading-order prediction is:

$$v_g^{(\text{MNT})} = c_{\text{MNT}}. \quad (7)$$

Comparison With Data

By construction, c_{MNT} is identified with the measured invariant speed c_{exp} when calibrating the theory to low-energy physics:

$$c_{\text{MNT}} = c_{\text{exp}} = 299\,792\,458 \text{ m s}^{-1}. \quad (8)$$

We can then write the fractional difference between gravitational-wave and electromagnetic speeds as:

$$\delta_{vg} \equiv \frac{v_g - c_{\text{exp}}}{c_{\text{exp}}}. \quad (9)$$

MNT/END predicts:

$$\delta_{vg}^{(\text{MNT})} = 0, \quad (10)$$

up to higher-order corrections that are not specified in the current manuscripts.

Observationally, constraints from GW170817-like events give:

$$\left| \delta_{vg}^{(\text{exp})} \right| \lesssim 10^{-15} \quad (11)$$

at roughly the 1σ level (here treated as an indicative uncertainty rather than a detailed statistical analysis).

Taking $\delta_{vg}^{(\text{exp})} \approx 0$ and $\sigma_\delta \approx 10^{-15}$, we can define:

$$\text{residual}_{T1} = \delta_{vg}^{(\text{MNT})} - \delta_{vg}^{(\text{exp})} = 0, \quad (12)$$

$$\text{pull}_{T1} = \frac{\text{residual}_{T1}}{\sigma_\delta} = 0, \quad (13)$$

$$\chi_{T1}^2 = \text{pull}_{T1}^2 = 0. \quad (14)$$

Status and Comments

Status: The test is satisfied at the level that MNT/END demands: an invariant propagation speed shared by electromagnetic and gravitational waves. Because the current documents fully identify c_{MNT} with the observed c_{exp} , this is effectively a *calibration plus consistency check* rather than a novel prediction.

A more discriminating version of T1 would require:

- explicit higher-order corrections from lattice structure or EQEF contributions that might slightly modify v_g or v_{EM} in specific regimes,
- and a calculation of those corrections showing that they remain below the 10^{-15} level for astrophysical sources like neutron-star mergers.

At present, the theory is consistent with existing bounds and does not predict any observable deviations in this sector.

3.2 T2: Fine-Structure Constant at Low Energy

Statement of the Test

Test T2 concerns the fine-structure constant α at a specified low-energy reference scale μ_0 (typically near zero momentum or an atomic scale). The questions are:

- How does MNT/END define and realize α in terms of its emergent constants?
- Is the low-energy value of α a prediction of the theory, or a calibration input?
- How does this relate to subsequent tests of running and unification?

MNT/END Structure

In standard form,

$$\alpha(\mu) = \frac{e^2(\mu)}{4\pi\epsilon_0\hbar(\mu)c(\mu)}. \quad (15)$$

Within the MNT/END lexicon:

- c_{MNT} is the emergent invariant speed.
- $\hbar_{\text{eff}}$ is the emergent quantum of action.
- e_{eff} is an effective electromagnetic coupling arising from discrete pattern structure and node interactions.

At a chosen reference scale μ_0 , the theory asserts that the combination

$$\alpha_{\text{MNT}}(\mu_0) \equiv \frac{e_{\text{eff}}^2(\mu_0)}{4\pi\epsilon_{0,\text{eff}}\hbar_{\text{eff}}c_{\text{MNT}}} \quad (16)$$

matches the observed low-energy value $\alpha_{\text{exp}}(\mu_0)$, and this match is then used to *fix* the product $\hbar_{\text{eff}}c_{\text{MNT}}$ in terms of e_{eff} and $\epsilon_{0,\text{eff}}$.

Calibration at the Reference Scale

At the reference scale μ_0 we therefore have the calibration condition

$$\alpha_{\text{MNT}}(\mu_0) = \alpha_{\text{exp}}(\mu_0) \approx \frac{1}{137.035999084}. \quad (17)$$

In the language of this report, that makes T2 at low energy a *calibration test*: it is used to fix a combination of emergent constants rather than to predict a new number.

We can write the residual at μ_0 as

$$\text{residual}_{\text{T2}} \equiv \alpha_{\text{MNT}}(\mu_0) - \alpha_{\text{exp}}(\mu_0) = 0, \quad (18)$$

by construction, and thus

$$\chi_{\text{T2}}^2 = 0 \quad (19)$$

at the calibration point.

Status and Comments

Status: At the level treated in the documents, T2 is passed by design: the emergent constants are calibrated such that $\alpha_{\text{MNT}}(\mu_0)$ equals the observed low-energy $\alpha_{\text{exp}}(\mu_0)$.

This is not yet a non-trivial prediction. For T2 to become predictive, the following would be required:

- A derivation of e_{eff} , $\varepsilon_{0,\text{eff}}$, and $\hbar_{\text{eff}} c_{\text{MNT}}$ entirely from discrete node parameters and the limit functional C_{tot} .
- An explicit renormalization-group description of $\alpha(\mu)$ within MNT/END, allowing comparison at multiple scales (atomic, m_Z , etc.) without inserting α_{exp} by hand.

Those ingredients are gestured at in the current manuscripts but not yet written out in sufficient detail to implement numerically, so we record T2 as a successful calibration rather than a hard constraint on the theory.

3.3 T3: Effective Gravitational Coupling and Planck Scale

Statement of the Test

Test T3 addresses the relationship between:

- the fundamental lattice/limit scale $M_\star$,
- the emergent gravitational coupling G_{eff} ,
- and the Planck scale M_{Pl} ,

as inferred from long-wavelength gravitational dynamics (Newtonian limit, weak-field GR, and cosmology).

The practical question is whether MNT/END can, from its discrete micro-structure, produce an effective Newton constant compatible with

$$G_{\text{exp}} \approx 6.67430 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}, \quad (20)$$

$$M_{\text{Pl}}^{(\text{exp})} \approx 2.17643 \times 10^{-8} \text{ kg}. \quad (21)$$

MNT/END Structure

The manuscripts sketch an effective relation of the schematic form

$$M_{\text{Pl}}^2 \sim \frac{M_\star^2}{\gamma_G}, \quad (22)$$

where γ_G is a dimensionless efficiency factor encoding how the lattice degrees of freedom and the global limit functional C_{tot} translate into long-range gravitational interactions.

However, in the uploaded texts:

- γ_G is not given as an explicit function of $(M_\star, \ell_0, \delta\tau, C_{\text{tot}}, \dots)$,
- no specific numerical value is assigned to $M_\star$,
- and the exact mapping from the discrete node action to an Einstein-Hilbert-like term is not carried out to the point of a concrete G_{eff} .

As a result, there is at present no fully worked-out formula that can be evaluated numerically to yield G_{eff} *ab initio*.

Calibration Versus Prediction

Using standard relations,

$$M_{\text{Pl}}^{(\text{exp})} = \sqrt{\frac{\hbar_{\text{exp}} c_{\text{exp}}}{G_{\text{exp}}}}, \quad (23)$$

one can always choose $M_\star$ and γ_G to satisfy (22) with

$$M_{\text{Pl}}^{(\text{MNT})} = M_{\text{Pl}}^{(\text{exp})}. \quad (24)$$

But that is a *calibration* of the combination $M_\star^2/\gamma_G$ using experimental input; it is not a prediction that can be falsified.

Given the current manuscripts, the best we can do is note that MNT/END has the structural capacity to host an emergent Planck scale consistent with data, but it does not yet produce a unique numerical value from first principles.

Status and Comments

Status: Conceptually aligned but not numerically predictive. T3 cannot presently contribute a non-trivial χ^2 term because the degrees of freedom that determine G_{eff} are not fixed well enough in the documents.

For T3 to become a quantitative test, the following would be needed:

- an explicit derivation of G_{eff} (or M_{Pl}) in terms of $M_\star$, ℓ_0 , $\delta\tau$, and the structure of C_{tot} ,
- a clear choice—or prediction—for $M_\star$,
- and, ideally, bounds on any corrections to Newtonian gravity at laboratory or solar-system scales.

3.4 Brief Status of T4–T20

For completeness, we summarize the status of tests T4–T20 as they appear in the MNT/END documents. In each case, the theory provides a plausible structural story, but the level of explicitness varies, and most are not yet ready for full numerical confrontation.

T4: Running of $\alpha(\mu)$

T4 concerns the renormalization-group running of the fine-structure constant from atomic scales to collider energies, and possibly up to unification scales.

Status: The documents describe qualitatively how the discrete progression and pattern structure underwrite an RG-like flow for couplings, and they assume SM-like behavior in the regime where the Standard Model is known to work. However, the explicit MNT/END-specific β -functions and thresholds are not spelled out. Without those, we cannot compute $\alpha(\mu)$ as a function of μ in a way that goes beyond simply importing the Standard Model result.

T5–T7: Charged-Lepton Masses and Muon Lifetime

These tests target:

- the ratios $m_e : m_\mu : m_\tau$,
- the overall lepton mass scale relative to electroweak parameters,
- and the muon lifetime, which in the Standard Model scales as

$$\tau_\mu^{-1} \propto G_F^2 m_\mu^5.$$

Status: The `MNT_Structural_Proofs` document outlines how mass spectra may be tied to eigenvalues of certain pattern operators on the node lattice, and how weak processes reflect specific pattern transitions. But explicit numerical eigenvalues, mixing matrices, and a concrete expression for an emergent G_F are not yet written down. Thus, T5–T7 currently remain at the level of structural plausibility, not quantitative prediction.

T8–T12: Electroweak, Neutrino, and Dark-Sector Links

These tests involve:

- the structure of electroweak symmetry breaking in the node framework,
- neutrino masses and mixings,
- possible CP violation patterns,
- and couplings to a latent or EQEF-like dark sector, including XENON-style direct-detection cross sections.

Status: Conceptual. The documents describe how node patterns could encode these sectors and how cross-sector couplings might arise, but do not provide a closed set of parameters plus formulas sufficient to calculate, for example, a neutrino mass ordering or a specific dark-matter scattering rate.

T13–T20: Further Gravitational and Mixed Tests

These include more detailed gravitational and mixed-sector observables: redshifts, time dilation, binary dynamics beyond T1, and interplays between gravity and other sectors.

Status: Partially specified conceptually, but lacking full numeric implementation. They mostly rely on the assumption that in appropriate limits the MNT/END continuum description reproduces general relativity plus standard matter, an assumption that remains to be demonstrated explicitly at the level of field equations and solutions.

In the rest of this report, we turn to the few tests that *can* be handled numerically with only the current material: notably T22 in the gravity sector.

3.5 T22: Equivalence Principle and Eötvös Parameter

Statement of the Test

Test T22 probes the equivalence principle in the MNT/END framework. In particular, it focuses on whether different compositions (different node-pattern realizations of matter) experience the same acceleration in a given gravitational field.

In standard notation, for two test bodies A and B ,

$$\eta_{AB} = 2 \frac{|a_A - a_B|}{a_A + a_B}, \quad (25)$$

where a_A and a_B are their measured free-fall accelerations. The equivalence principle is satisfied if $\eta_{AB} = 0$.

Modern experiments (e.g. MICROSCOPE) constrain

$$\eta_{AB}^{(\text{exp})} = 0 \pm 2 \times 10^{-13}. \quad (26)$$

MNT/END Expectation

The MNT/END manuscripts assert that, in the appropriate long-wavelength limit:

- the emergent description of gravity is metric and universal,
- inertial and gravitational responses of node configurations coincide to leading order,
- composition-dependent effects, if any, are higher order and suppressed below current experimental sensitivities.

In that regime, MNT/END predicts

$$\eta_{AB}^{(\text{MNT})} = 0, \quad (27)$$

for all pairs (A, B) used in present-day equivalence-principle tests.

The documents do discuss possible subtle corrections from latent sectors or small pattern differences, but these are not quantified with explicit formulas or parameter values. For the purposes of this report, we therefore take

$$\eta_{AB}^{(\text{MNT})} = 0 \quad (28)$$

as the working prediction.

Numerical Comparison

Adopting $\eta_{AB}^{(\text{exp})} = 0$ with an indicative 1σ uncertainty

$$\sigma_\eta = 2 \times 10^{-13}, \quad (29)$$

we define

$$\text{residual}_{\text{T22}} = \eta_{AB}^{(\text{MNT})} - \eta_{AB}^{(\text{exp})} = 0, \quad (30)$$

$$\text{pull}_{\text{T22}} = \frac{\text{residual}_{\text{T22}}}{\sigma_\eta} = 0, \quad (31)$$

$$\chi_{\text{T22}}^2 = \text{pull}_{\text{T22}}^2 = 0. \quad (32)$$

Status and Comments

Status: T22 is passed at the level of current documentation: MNT/END built as an emergent metric theory is compatible with the extremely small observed Eötvös parameter. However, as with T1 and the low-energy part of T2, this is more a consistency statement than a sharp prediction, because the theory is constructed to recover universality of free fall at leading order.

A more stringent future version of T22 would require:

- explicit expressions for composition-dependent corrections to free-fall accelerations in MNT/END,
- and a demonstration that such corrections are below the 10^{-13} level for the specific compositions used in experiments, or else a prediction of small deviations that could be probed next-generation.

4 Global Status Summary

4.1 Quantitatively Implemented Tests

With the six current manuscripts and the “no new assumptions” rule, the following tests can be implemented quantitatively:

- **T1 (Invariant speed / gravitational waves):** MNT/END predicts $v_g = c_{\text{MNT}}$, and c_{MNT} is calibrated to c_{exp} . Gravitational-wave observations constrain $|v_g - c|/c \lesssim 10^{-15}$, consistent with the MNT/END prediction of zero fractional difference at leading order. Residual and χ^2 are effectively zero by calibration.
- **T2 (Low-energy α):** The emergent constants are chosen such that $\alpha_{\text{MNT}}(\mu_0) = \alpha_{\text{exp}}(\mu_0)$ at a reference scale. This fixes a combination of $\hbar_{\text{eff}}$, c_{MNT} , and e_{eff} . Again, residual and χ^2 vanish by construction.
- **T22 (Equivalence principle / Eötvös parameter):** MNT/END yields a universal metric description of gravity and predicts $\eta_{AB}^{(\text{MNT})} = 0$ at leading order. This is fully consistent with the current bound $\eta_{AB}^{(\text{exp})} = 0 \pm 2 \times 10^{-13}$, giving zero residual and zero χ^2 within the simplified treatment here.

If one were to define a “global χ^2 ” from these three implemented tests alone, it would be identically zero, but that is not informative because all three are either calibrations or direct consequences of built-in symmetries.

4.2 Conceptual and Partially Specified Tests

The majority of the remaining tests (T3–T21, T23–T50) are one of:

- **Conceptual:** The test is clearly posed (e.g. neutrino mass patterns, dark-sector direct detection, cosmological expansion history) and MNT/END offers a structural story for how it might be addressed, but the manuscripts stop short of giving the explicit formulas and parameter values needed for numerical confrontation.
- **Partially specified:** Some ingredients are present (e.g. schematic relations between $M_\star$ and M_{Pl} , rough outlines of pattern spectra for masses), but crucial details are missing, such as full eigenvalue spectra, mixing matrices, or precise micro-to-macro mappings for couplings.

Notable examples:

- **T3 (Planck scale / G_{eff}):** Relation $M_{\text{Pl}}^2 \sim M_\star^2/\gamma_G$ is sketched, but γ_G and $M_\star$ are not specified; the test remains conceptual.
- **T4 (Running of α):** The existence of RG-like running is acknowledged, but the explicit MNT/END β -functions are not provided.
- **T5–T12 (leptons, Higgs, neutrinos, dark sector):** Pattern-based mechanisms are described qualitatively; explicit numerical spectra and rates are not.
- **T23–T25 and cosmological tests:** The theory aims to reproduce GR-like cosmology with possible corrections, but the full effective equations and parameter mappings from node-level quantities are not yet written down.

5 Limitations and Roadmap

5.1 Limitations of This Report

This report is deliberately conservative:

- It does not invent missing terms, couplings, or parameter values in order to force a prediction.
- It treats any use of experimental numbers to fix emergent constants *explicitly* as calibration.
- It refrains from inferring more detailed dynamics than the manuscripts actually specify.

As a result, many tests are labeled “conceptual” or “partially specified” rather than “passed” or “failed.” This is a reflection of the current level of detail in the written corpus, not necessarily a limitation of the underlying ideas.

5.2 Roadmap to a Full Numerical Global Fit

To elevate the 50-test suite from a conceptual alignment checklist to a rigorous, over-constrained numerical testbed, several developments are needed:

1. **Explicit derivation of G_{eff} and M_{Pl} :**
Carry the mapping from discrete node dynamics and C_{tot} all the way to an Einstein-Hilbert-like effective action, fixing γ_G and $M_\star$ sufficiently to compute G_{eff} without calibration.
2. **Complete pattern spectra for Standard-Model fields:**
Provide explicit eigenvalues and overlaps for the operators encoding charged leptons, quarks, and neutrinos, plus the associated mixing matrices (CKM and PMNS) and CP phases.
3. **MNT/END-specific renormalization-group equations:**
Derive β -functions for gauge, Yukawa, and scalar couplings, including any contributions from latent or EQEF sectors. This would underwrite tests of running couplings and possible unification scenarios (T4 and related).
4. **Cosmological coarse-graining:**
Develop a clear FRW-like limit, specifying how node-level parameters determine H_0 , Ω parameters, and the effective dark-energy or modified-gravity sector, enabling hard tests against CMB, BAO, and supernova data.

5. **Concrete latent-sector benchmarks:**

Choose and analyze specific mass/coupling benchmarks for the latent sector to compute direct-detection cross sections (T10/T21) and cosmological impacts (T41–T48).

6. **Numerical lattice implementations:**

Implement MNT/END dynamics in simulations to directly test claims of numerical reproducibility, meta-closure, and absence of hidden knobs (T49–T50).

6 Conclusion

Within the scope of the six core manuscripts and the constraint of adding no new assumptions, the present report finds:

- MNT/END is structurally capable of reproducing key features of observed physics: a universal invariant speed shared by electromagnetic and gravitational waves, a low-energy fine-structure constant matching experiment after calibration, and a universal metric gravity consistent with current equivalence-principle bounds.
- Only a small subset of the 50 tests (notably T1, the low-energy part of T2, and T22) can be rendered numerical with the current level of detail, and these yield vanishing residuals by construction or by built-in symmetries.
- The majority of tests remain conceptual or partially specified, highlighting where further derivations, explicit formulas, or parameter fixing are needed rather than indicating any contradiction with data.

The 50-test suite, together with this status report, can therefore be viewed as a roadmap: it delineates the path from the current, structurally rich but partially specified theory documents to a fully quantified, falsifiable framework. Completing that path will require filling in the micro-to-macro derivations that take MNT/END from discrete node dynamics all the way to the precise numbers catalogued by CODATA, PDG, and cosmological surveys.