

# LFM Phase 1 Test Design

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## Lattice-Field Medium (LFM): Phase 1 Test Design — Proof-of-Concept Validation System

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### Abstract

Phase 1 defines the design and implementation framework for validating the Lattice-Field Medium (LFM) through reproducible Tier 1–5 tests. It specifies the environment, configuration architecture, pass/fail criteria, and proof-packet generation protocol required to establish numerical and physical correctness of the model including complete electromagnetic theory validation. This version modernizes the document layout for reproducibility and OSF publication compliance.

### 1 Purpose

Phase 1 establishes the full architecture for the LFM Proof-of-Concept Validation System. The goal is to provide a reproducible testing environment that demonstrates Tier 1–5 correctness and creates a foundation for expert review.

### 2 Hardware and Environment

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Component Specification Notes

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System MSI Katana A15 AI Primary development node

CPU / GPU Ryzen 7 8845HS / RTX Hardware sufficient for all 4060 (8 GB VRAM) Tier 1–5 test campaigns

RAM / Storage 32 GB / 1 TB SSD Sufficient for 3D Tier 3 tests

OS Windows 11 x64

Python Environment 3.11.9 + NumPy, SciPy, Standard computation Numba, CuPy-CUDA12x stack

Version Control Git (local → GitHub Ensures provenance and private) reproducibility

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### 3 Folder and File Architecture

The LFM Proof-of-Concept environment follows a strict folder structure: LFM\code — Source modules and Tier kernels LFM\config — JSON configuration and thresholds LFM\runs — Runtime data for each experiment LFM\results — Metrics, plots, and summaries LFM\logs — Execution and environment logs LFM\packages — Proof-packet archives

### 4 Configuration and Validation Logic

Global tolerances reside in /config/validation\_thresholds.json, with Tier-specific overrides in /config/tierN\_default.json. Merge order: global → local → runtime. Configuration keys include tier, parameters, tolerances, run\_settings, and notes.

### 5 Pass/Fail Framework

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#### Tier Goal Pass Criteria (Phase 1)

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1 Lorentz isotropy &  $\Delta v/c$  1 %, anisotropy 1 %; energy drift within typical dispersion bounds  $10^{-10}$  ...  $10^{-11}$  depending on grid/BCs

2 Weak-field / redshift Correlation  $> 0.95$  with analytic model; drift 1 %

3 Energy conservation Relative energy drift  $|\Delta E| / |E|$  within  $10^{-10}$  ...  $10^{-11}$  typical; strict baseline tolerance configured as  $1 \times 10^{-12}$  in /config/validation\_thresholds.json for conservative runs

4 Quantum behavior Discrete energy eigenvalues with  $< 2\%$  error; quantum tunneling demonstrated; uncertainty relation  $\Delta x \cdot \Delta k = 0.5$  confirmed

5 Electromagnetic theory Complete Maxwell equation validation; Coulomb's law  $E = kq/r$  within  $\pm 0.1\%$ ; electromagnetic wave speed  $c = 1/\sqrt{\epsilon_0 \mu_0}$  confirmed; `{{PASS_RATE:Electromagnetic}}` test success rate on implemented electromagnetic phenomena

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### 6 Orchestration and Parallelism

The master script run\_all\_tiers.py references /config/orchestration.json to schedule tiers and variants with a concurrency limit (default 3). Each run executes run\_tier.py, writes results, and

aggregates metrics into `/results//summary_overall.json`.

## 7 Visualization and Reporting

Plots auto-generate under `/results////plots/`. Each follows scientific styling standards (`energy_vs_time`, `anisotropy_vs_time`, etc.). A summary dashboard (`summary_dashboard.html`) compiles all Tier results.

## 8 Expert Review Packaging Workflow

After all Tier tests complete, the system assembles a proof packet in `/packages/LFM_ProofPacket__vX.Y.zip`. Each archive contains README, manifest, environment info, configs, code snapshot, results, logs, and SHA-256 hashes. Integrity checks and optional Cardano anchoring ensure reproducibility.

## 9 Phase 1 Test Scope

Phase 1 currently executes Tier 1–5 tests. Canonical expected counts are tracked in the results registry; refer to the results rollups for authoritative counts. Additional exploratory tests may be present. Refer to the per-tier results under `results//*` for PASS/FAIL/SKIP status. Expected duration for a full run depends on hardware and concurrency.

## 10 Data Reproducibility and Licensing

All code and data products are released under CC BY-NC-ND 4.0 (non-commercial, attribution required; no derivatives). Each result file includes environment hashes and deterministic seeds. Reproducibility requires the same configuration files and random seed identifiers as recorded in the proof packets.

## 11 Metadata Alignment

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Field Value

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Keywords lattice field theory; discrete spacetime; emergent relativity; reproducibility; computational physics

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Category Tags Theoretical Physics · Computational Physics · Simulation Frameworks

Data Availability All proof packets and logs provided as supplemental data under reproducible archive.

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## 12 Summary

Phase 1 provides the reproducibility framework for all Tier 1–5 LFM tests. It defines configuration structure, orchestration logic, validation thresholds, and proof-packet packaging. Successful completion confirms the model’s stability, isotropy, conservation, quantum behavior, and electromagnetic theory reproduction—forming a complete empirical foundation for this phase.

## 13 Legal & Licensing Notice

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