# 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 1–3 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. 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 1–3 correctness and creates a foundation for higher-tier extensions and expert review.

## 2 Hardware and Environment

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| Component | Specification | Notes |
| System | MSI Katana A15 AI | Primary development node |
| CPU / GPU | Ryzen 7 8845HS / RTX 4060 (8 GB VRAM) | Tier 6-capable hardware |
| RAM / Storage | 32 GB / 1 TB SSD | Sufficient for 3D Tier 3 tests |
| OS | Windows 11 x64 |  |
| Python Environment | 3.11.9 + NumPy, SciPy, Numba, CuPy-CUDA12x | Standard computation stack |
| Version Control | Git (local → GitHub private) | Ensures provenance and reproducibility |

## 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

|  |  |  |
| --- | --- | --- |
| Tier | Goal | Pass Criteria |
| 1 | Lorentz isotropy & dispersion | Δv/c < 1 %; anisotropy < 1 %; energy drift ≤ 1e-6 |
| 2 | Weak-field / redshift analogue | Correlation > 0.95 with analytic model; drift ≤ 1 % |
| 3 | Energy conservation | |ΣΔE| / ΣE < 1e−12 |

## 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/<campaign>/summary\_overall.json.

## 7 Visualization and Reporting

Plots auto-generate under /results/<campaign>/<tier>/<variant>/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\_<campaign>\_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 executes 26 Tier 1–3 tests: 9 Relativistic, 8 Gravity-Analogue, and 9 Energy-Conservation tests. Expected duration: ~6 weeks with full parallelization.

## 10 Data Reproducibility and Licensing

All code and data products are released under CC BY-NC 4.0 (non-commercial, attribution required).. 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 OSF Metadata Alignment

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| --- | --- |
| Field | Value |
| Keywords | lattice field theory; discrete spacetime; emergent relativity; reproducibility; computational physics |
| License | License CC BY-NC 4.0 (non-commercial, attribution required) |
| Category Tags | Theoretical Physics · Computational Physics · Simulation Frameworks |
| Data Availability | All proof packets and logs provided as supplemental OSF data under reproducible archive. |
| Funding / Acknowledgements | Self-funded; no external sponsors. |
| Contact | [gpartin@gmail.com](mailto:gpartin@gmail.com) |

## 12 Summary

Phase 1 provides the reproducibility framework for all Tier 1–3 LFM tests. It defines configuration structure, orchestration logic, validation thresholds, and proof-packet packaging. Successful completion confirms the model’s stability, isotropy, and conservation—forming the empirical base for Tier 4–6 development.