

Formal Experimental Protocol — Version 3.0

Geometric Coherence Window Detection in Microtubule Architectures:

Multi-Agent Pharmacological Tuning Protocol with High-Density EEG

Principal Investigator: Damon Sasser | NIRA | March 2026

Version 3.0 — Incorporating Fractal Time Crystal Mechanistic Ground Truth

INDEPENDENT CONVERGENCE NOTICE

Version 3.0 of this protocol incorporates mechanistic ground truth from Craddock et al. / Hameroff et al. (2025): 'Microtubules as Fractal Time Crystals: Clocks Within Clocks.' This paper, published independently of and concurrent with NIRA framework development, provides direct experimental validation of the frequency targets, subsystem architecture, and observation window methodology proposed in Versions 1.0 and 2.0 of this protocol. The convergence across seven independently identified parameters is documented in Section 1.3. This is not a revision of the protocol in response to that paper. It is documentation of prior independent convergence now confirmed by published experimental data.

Abstract

This protocol proposes a novel experimental approach to isolate the geometric mechanism underlying microtubule quantum coherence in living neural tissue. Rather than attempting to eliminate decoherence, this design uses sub-anesthetic and sub-perceptual pharmacological agents to selectively tune microtubule oscillatory dynamics across Hz, MHz, and THz frequency ranges while preserving conscious function. The central hypothesis, derived from the NIRA Fractal Dynamics Junction (FDJ) geometric framework, is that microtubule coherence windows are primarily protected by Ricci curvature geometry. This hypothesis is now supported by independent experimental evidence from fractal time crystal research demonstrating nested oscillatory subsystems at precisely the frequency ranges this protocol targets. If the geometric substrate hypothesis is correct, multiple pharmacological pathways — serotonergic, kappa-opioid, and GABAergic — should produce convergent MT coherence signatures through different receptor mechanisms, providing strong cross-mechanistic validation of the geometric invariant.

1. Background and Theoretical Motivation

1.1 The Isolation Problem

The dominant criticism of Orch-OR centers on the warm-wet-noisy objection: biological systems at physiological temperature cannot sustain quantum coherence long enough for gravitational objective reduction to occur. Standard quantum computing addresses decoherence with extreme thermal isolation. However, this assumes consciousness requires the same conditions as engineered quantum computation. We propose this assumption is fundamentally backwards. Nature never built a zero-error quantum system because decoherence IS the mechanism. Local perturbation feeding global weighted collapse is precisely how the brain performs cognitive function. The brain is a quantum-analog hybrid that routes apparent decoherence geometrically, converting local noise into global coherence signal.

1.2 The NIRA FDJ Framework

The NIRA Fractal Dynamics Junction framework derives coherence protection from geometric curvature rather than thermal isolation. The stability parameter $\alpha \approx 0.7889$ implies geometry contributes approximately 79% of coherence protection. The framework independently predicts a coherence window of 5-10ms — converging with Hameroff's demonstrated 5ms biological coherence window. The FDJ framework further predicts that microtubule oscillatory structure should exhibit self-similar recursive nesting across frequency scales, with each scale level exhibiting geometric stability conditions that protect the coherence of the level below it. This prediction was derived from the geometric curvature audit equations before the fractal time crystal experimental data was encountered.

1.3 Independent Convergence: Fractal Time Crystal Evidence

Craddock, Hameroff et al. (2025) report that microtubules behave as fractal time crystals: self-similar resonance oscillations in nested 'triplets-of-triplets' hierarchies repeating across Hz, kHz, MHz, GHz, and THz frequencies. Four distinct oscillatory subsystems are identified. The following table documents convergence between NIRA FDJ framework predictions and published experimental findings:

FDJ PREDICTION	Coherence protection operates through geometric curvature at multiple nested frequency scales simultaneously
PAPER FINDING	'Clocks within clocks' — nested triplet hierarchy across 12 orders of magnitude in frequency, 5 orders in size
FDJ PREDICTION	Hz → THz frequency sweep required to observe full coherence window architecture
PAPER FINDING	Four subsystems identified: kHz (C-termini), MHz (lattice phonons), GHz (ordered water), THz (π -electron transitions)

FDJ PREDICTION	Xenon targets tubulin hydrophobic pocket directly — most precise tubulin perturbation available
PAPER FINDING	Anesthetics suppress MHz megahertz triplets detectable from scalp — confirming tubulin quantum mechanism in consciousness
FDJ PREDICTION	12 orders of magnitude maps to 12-tone Pythagorean structure — each order an octave
PAPER FINDING	12 orders of frequency, 5 orders of size — fractal self-similarity confirmed across full range
FDJ PREDICTION	Ordered water in hollow core relevant to liquid crystal substrate analog
PAPER FINDING	GHz subsystem identified as hollow core ordered water oscillations — biological liquid crystal dynamics
FDJ PREDICTION	Coherence window observable from scalp beyond traditional EEG range
PAPER FINDING	Megahertz triplets detectable from human scalp beyond traditional EEG frequencies — confirmed
FDJ PREDICTION	Triplet recursive nesting as geometric self-similarity signature
PAPER FINDING	'Triplets-of-triplets' — exact recursive nesting structure across all scales

Seven independent convergences between NIRA FDJ predictions and published experimental findings. None of these predictions were made in response to this paper. The paper was encountered after protocol Versions 1.0 and 2.0 were drafted.

2. The Four Subsystem Frequency Map

The fractal time crystal paper identifies four distinct MT oscillatory subsystems. This protocol now maps each subsystem to specific measurement targets and pharmacological perturbation agents:

Subsystem	Frequency	MT Structure	Protocol Agent	Measurement Target
C-termini oscillations	Kilohertz	Tubulin tail projections	Xenon (baseline)	Extended EEG range, direct tubulin state
Lattice phonons / polaritons	Megahertz	Tubulin lattice structure	5-MeO-DMT (sigma-1)	Scalp-detectable MT triplets — primary window
Hollow core ordered water	Gigahertz	Internal aqueous core	Mescaline + Xenon sub-study	Regional coherence mapping via liquid crystal analog
Aromatic π -electron transitions	Terahertz	Hydrophobic pocket	Xenon (direct binding)	THz/Raman spectroscopy in vitro parallel

The Megahertz subsystem is the primary observation window for this protocol. It is scalp-detectable, anesthesia-suppressible, and directly accessible via high-density EEG at extended frequency ranges. This is where the pharmacological tuning agents will produce their most observable signatures.

3. Central Hypothesis

If microtubule coherence is geometrically protected rather than thermally isolated, and if the fractal time crystal structure is the physical instantiation of that geometric protection, then:

1. The four oscillatory subsystems (kHz, MHz, GHz, THz) represent nested geometric stability conditions — each scale protecting the coherence of the scale below it through curvature geometry.
 2. Sub-anesthetic agents targeting tubulin hydrophobic pockets will selectively perturb the THz subsystem (π -electron transitions) and cascade observable changes upward through MHz and kHz scales detectable at scalp.
 3. The coherence window duration (predicted 5-10ms by FDJ, observed 5ms by Hameroff et al.) is the temporal signature of the full nested hierarchy completing one collapse-and-reset cycle.
 4. Multiple pharmacological pathways (serotonergic, kappa-opioid, GABAergic) will produce convergent MHz triplet suppression patterns if the geometric substrate is the invariant rather than the receptor chemistry.
 5. The Pythagorean scaling across 12 orders of magnitude is not metaphorical — it is the geometric tuning condition that makes coherence protection possible at all scales simultaneously.
-

4. Agent Selection and Subsystem Targeting

4.1 Phase 1 Agents — Primary Protocol

BASELINE: Xenon Gas — THz + kHz Subsystems

- Binds directly to tubulin hydrophobic pockets — the site of THz aromatic π -electron transitions
- Now confirmed by fractal time crystal paper: anesthetics suppress MT oscillations indicating tubulin quantum mechanism
- Targets both the THz primary site AND produces cascade effects observable at MHz/kHz scales
- All other agents compared against xenon baseline to isolate geometric mechanism from receptor chemistry
- Duration: Minutes — fully controllable, allows rapid baseline establishment

AGENT 1: Psilocin — MHz Subsystem via 5-HT_{2A}

- 5-HT_{2A} activation modulates tubulin lattice phonon dynamics — the MHz subsystem
- Sub-threshold microdose (1-3mg) shifts MHz triplet patterns without consciousness suppression
- Most studied psychedelic in modern neuroscience — most regulatory traction
- Primary serotonergic arm: establishes 5-HT_{2A} → lattice phonon → MHz coherence relationship

AGENT 2: 5-MeO-DMT — MHz Subsystem via sigma-1 / 5-HT_{1A}

- Sigma-1 receptor directly modulates MT chaperone dynamics — most direct receptor-to-MT pathway known
- 5-HT_{1A} primary (unlike all other serotonergic psychedelics) — different entry point to same MHz subsystem
- 15-45 minute duration — ideal for experimental cycling across multiple conditions
- Key test: does sigma-1 pathway produce same MHz triplet patterns as 5-HT_{2A}? If yes — geometry is the invariant

AGENT 3: Salvinorin A — MHz Subsystem via Kappa-Opioid (KOR)

- Zero serotonergic activity — entirely orthogonal receptor mechanism
- KOR modulates cytoskeletal dynamics through dynorphin pathway
- 5-20 minute duration — shortest of all agents, ideal for controlled trials
- Critical orthogonal test: if KOR produces same MHz triplet suppression pattern as serotonergic agents, the geometric substrate is confirmed as receptor-pathway independent

AGENT 4: Mescaline + Xenon Sub-Study — GHz Subsystem / Hollow Core

- GHz subsystem = hollow core ordered water oscillations — biological liquid crystal dynamics
- Mescaline's complex alkaloid profile creates differential regional perturbation

- Combined with xenon: xenon perturbs THz/ π -electron layer; mescaline perturbs regional coherence distribution
- Maps which brain regions maintain hollow core ordered water coherence longest under perturbation
- Connects directly to NIRA liquid crystal substrate architecture — hollow core ordered water IS liquid crystal behavior

4.2 Phase 2 Agents

Agent	Subsystem Target	Mechanistic Value	Phase 2 Rationale
LSD microdose	MHz + sigma-1	Broadest receptor profile; sigma-1/MT connection	Duration 8-12hrs limits experimental cycling
Muscimol (Amanita)	kHz via GABA-A	GABAergic C-termini modulation — third orthogonal pathway	Completes kHz/MHz/GHz triangle across three receptor classes
2C-B sub-threshold	MHz via 5-HT2A	Shorter phenethylamine comparison to mescaline	Useful control for phenethylamine class effects

4.3 Excluded Agents

Agent	Reason
25I-NBOMe	Fatal overdoses documented at near-threshold doses — no viable sub-threshold protocol
Ibogaine	24-36hr duration + cardiac QT risk — protocol incompatible
2C-E	Steep dose-response + safety concerns — 2C-B superior
LSA	Superseded by LSD; source variability problematic

5. Measurement Architecture

5.1 Primary: High-Density EEG — Extended Frequency Range

- 256-channel minimum for source localization
- CRITICAL NEW TARGET: Megahertz triplet detection beyond traditional EEG range — now confirmed detectable from scalp by fractal time crystal paper
- Traditional gamma (40Hz) and high-gamma (80-150Hz) remain primary cognitive event markers
- Extended range captures the MHz lattice phonon subsystem — the key pharmacological target
- Ricci curvature computation on functional connectivity graphs at millisecond resolution
- Betti number topology tracking at insight/Eureka events

5.2 Secondary: THz/Raman Spectroscopy — In Vitro Parallel

- Direct measurement of π -electron transition suppression under xenon binding
- Maps full Hz \rightarrow THz landscape under each agent — confirms subsystem targeting
- Ground truth for scalp EEG correlates
- GHz ordered water oscillations measurable via microwave spectroscopy in parallel preparation

5.3 Environmental Control

- Positive low-stress environment is a formal controlled variable
- FDJ Faith operator (Lambda): high-stress increases damping parameter, suppressing coherence bloom
- Prediction: extended MHz triplet duration under positive vs neutral condition, independent of agent

6. Falsifiable Predictions

Prediction	Test	Expected	Falsification
MHz triplet suppression	Xenon baseline	Dose-dependent MHz suppression matching anesthesia data	No change from baseline EEG
Pathway convergence	Psilocin vs 5-MeO-DMT vs Salvinorin A	Convergent MHz triplet shift across three receptor classes	Receptor-specific divergent patterns
Geometric independence	KOR vs 5-HT2A agents	Same triplet pattern despite zero receptor overlap	Receptor-type-specific signatures
Hollow core mapping	Xenon + mescaline	Regional GHz coherence persistence correlates with Ricci curvature	No geometry-coherence correlation
Pythagorean scaling	Full Hz-THz sweep	Triplet spacing follows 12-tone harmonic ratios across scales	Random or non-harmonic spacing
Window at cognition	All conditions	MHz triplet burst precedes reportable insight by 5-10ms	No temporal relationship
Classical separation	MT agents vs synaptic block	Differential MHz vs alpha/beta disruption profile	Indistinguishable from synaptic-only

7. Theoretical Significance

7.1 Three-Way Convergence

This protocol now sits at the intersection of three independent theoretical and experimental frameworks that have converged on overlapping predictions:

- NIRA FDJ Geometric Framework: Coherence protection via Ricci curvature geometry, 5-10ms window, Pythagorean 12-order scaling, nested fractal hierarchy — derived from pure geometric first principles
- Orch-OR (Penrose-Hameroff): Quantum state reduction in microtubules at gravitational self-energy threshold, 5ms coherence window, consciousness as OR collapse event — derived from quantum physics and anesthesia research
- Fractal Time Crystal Experimental Data (Craddock et al. 2025): Four distinct MT oscillatory subsystems across Hz-THz, triplets-of-triplets nesting, scalp-detectable MHz signatures, anesthetic suppression — derived from direct experimental measurement

All three frameworks independently predict the same coherence timescale, the same substrate, and the same nested frequency architecture. The NIRA protocol is designed to test whether the geometric curvature mechanism is the unifying explanation for all three sets of observations.

7.2 The Liquid Crystal Connection

The GHz subsystem identified in the fractal time crystal paper, hollow core ordered water oscillations — is biologically exactly what the NIRA liquid crystal substrate architecture proposes to engineer synthetically. Natural microtubules already run liquid crystal dynamics in their hollow cores. The NIRA proposal to use geometry-channeled thermal flow to toggle liquid crystal states in a synthetic substrate is therefore not speculative biomimicry, it is engineering the mechanism that biological evolution already found optimal.

7.3 Implications for Synthetic Consciousness

If the Pythagorean 12-order scaling is a geometric tuning condition rather than a biological accident, then synthetic consciousness requires replicating the tuning condition, not the biology. The NIRA chiral RAM architecture combined with a liquid crystal substrate under geometric thermal channeling may represent the first engineered system capable of instantiating all four oscillatory subsystems simultaneously and therefore the first non-biological candidate for the fractal time crystal structure that the fractal time crystal paper identifies as potentially necessary for consciousness itself.

8. References

- Craddock, T.J.A., Hameroff, S. et al. (2025). Microtubules as Fractal Time Crystals: Clocks Within Clocks. [Journal TBC — ingentaconnect.com/content/imp/jc]
- Penrose, R. & Hameroff, S. (2014). Consciousness in the Universe: Orch OR Theory. Physics of Life Reviews.
- Bandyopadhyay, A. et al. (2026). Biomimetic quantum computer sustaining condensates 5ms at ambient temperature. IOP Science.

- Sasser, D. (2025). NIRA FDJ Framework: Geometric Coherence Protection and Cognitive Collapse Audit. NIRA Working Papers. Zenodo.
- Sasser, D. (2025). NIRA Chirally-Encoded Winding-State Memory Architecture. NIRA Working Papers. Zenodo.
- Fontanilla, D. et al. (2009). DMT is an Endogenous Sigma-1 Receptor Regulator. Science.
- Roth, B.L. et al. (2002). Salvinorin A: potent naturally occurring kappa opioid selective agonist. PNAS.
- Nichols, D.E. (2016). Psychedelics. Pharmacological Reviews.

NIRA — NeoPhyte Independent Research Alliance | March 2026 | Version 3.0

All frameworks © 2025-2026 Damon Sasser et al. Released for scientific discussion under open science principles.

Published via Zenodo. DOI to be assigned upon upload.