Stage 11 Execution Plan: Phantom Well Hunting

This document outlines the execution plan for Stage 11 of the NGeodesic project. The overarching theme of this stage is **phantom well hunting**. Our objective is to identify phantom wells, differentiate them from the true well, and develop strategies to mitigate their effects on hallucination rates.

Stepwise Plan

1. Formalize the Energy Landscape: Define per-primitive potentials and margin $\Delta = U_{false} - U_{true}$ as the measure of well depth.
2. Improve Orthogonalization: Replace mean-only subtraction with low-rank projection. Project onto orthogonal complements to enlarge Δ.
3. Strengthen Calibration: Enhance permutation null with block circular shifts and optionally multitaper averaging.
4. Sequential Residual Refinement: After selecting a primitive, subtract prototype contributions and recompute z-scores to deepen wells.
5. Lateral Inhibition: Introduce penalties for overlapping activations with a Gaussian kernel to suppress distractor basins.
6. Controlled Descent: Introduce a temperature parameter T, beginning with high exploration and annealing to low convergence.
7. Evaluation Metrics: Track hallucination rate, recall, F1, Jaccard, and exact grid accuracy as components are added.

Phantom Well Hunting Strategy:
1. Run benchmarks using *stage11-well-benchmark.py* as the base script.
2. Analyze margin distributions to distinguish true vs. phantom wells.
3. Validate wells using sequential residual refinement — true wells reduce residual energy; phantoms do not.
4. Apply lateral inhibition to suppress phantom activations.
5. Evaluate improvements in hallucination suppression and stability.

Visualization Plan:
At the end of Stage 11, project the warped manifold down to 3D for visualization. This will reveal the topology with the true well and all phantom wells, enabling intuitive understanding of the energy landscape.

Breaking Point:
Stage 11 represents the transition from heuristic parsing to an explicit warped manifold energy framework. Here hallucinations are eliminated by construction. The phantom well strategy ensures robustness by addressing misleading basins in the manifold.