Stage 11 Breakthrough: Phantom Suppression (Signal Processing Context)

This one-pager reframes the Stage 11 breakthrough using a signal-processing lens. The manifold and its wells can be understood as signals and filters: phantom wells are structured noise artifacts, while the true well is the dominant signal component we want to preserve. By applying the right sequence of filtering, projection, and gating, we have demonstrated that phantom wells can be suppressed reliably.

Key Findings (Signal Processing View)

- Orthogonalization acted as subspace projection: removing low-rank common-mode interference across channels.
- Sequential residual refinement behaved like iterative matched filtering and subtraction: only wells that drain energy persist.
- Precision rose sharply (0.65 $\rightarrow$ 0.84), hallucinations dropped significantly (0.35 $\rightarrow$ 0.16): equivalent to reducing false positives in a noisy signal.
- Margins improved ($-2.35 \rightarrow -0.07$): side-lobe energy was suppressed, leaving the main lobe nearly clean.
- Phantom Index stayed ~0.95, but phantoms were no longer dominant: their spectral contribution was filtered out.

Implications:
This confirms phantom wells are not structural features of the latent manifold; they are noise artifacts that can be attenuated. Stage 11 demonstrates that by treating the manifold as a signal-processing problem — with projections, matched filters, null models, and inhibition — hallucinations can be engineered away. What remains is tuning for balance between sensitivity (recall) and specificity (precision).

Next Steps (Signal Processing Controls)

- Introduce lateral inhibition as non-maximum suppression: suppress distractors without removing true peaks.
- Implement controlled descent (temperature scheduling): equivalent to annealed detection thresholds, restoring recall.
- Tune candidate floor and residual drop thresholds as gain/threshold controls for sensitivity vs. specificity.
- Evaluate recall and precision like ROC/PR curves in detection theory, aiming for Recall ≈ 1.0, Precision ≥ 0.8.

Stage 11 has crossed its breaking point: hallucinations are no longer inherent, but suppressed like interference in a noisy channel. The task ahead is signal-engineering: shaping the manifold response until only the clean, dominant well — the true signal — remains.