EXPERIMENTAL & MEASUREMENT FINDINGS

Key Distinction:
- Physical entropy ≠ Measurable (estimated) entropy
- Many apparent decoherence effects are inference-limited, not physics-limited

Observed 40–50% Entropy Zone:
- Occurred in 16–23+ qubit experiments
- Initially interpreted as decoherence / NISQ failure
- Actually caused by insufficient measurement shots
- Estimator bias pushes reconstructions toward maximally mixed states
- Represents a measurability ceiling, not a physical ceiling

Measurement Bottleneck:
- Hilbert space grows exponentially with qubits
- Fixed or weakly scaling shot counts under-sample state space
- Under-sampling inflates estimated entropy
- Bridge Quality (BQ) degrades due to inference loss

Shot Scaling Breakthrough:
- Scaling measurement shots as:
  shots ~ 2^(n/2) × constant
- Crossed tomographic sufficiency threshold
- Restored estimator fidelity
- Recovered correlations already present in hardware

Effect of Shot Scaling:
- Did NOT increase physical coherence
- Did NOT reduce thermodynamic entropy
- DID reduce estimation entropy
- DID convert hidden quantum structure into recoverable information
- Escaped the 40–50% measurement-limited plateau

“Negentropy” (Corrected Meaning):
- Not physical negentropy
- Not entropy decrease in the system
- Correct interpretation:
  → Net information gain per measurement cycle
  → Reduction of estimator-induced entropy
- Best term: inference negentropy / estimation negentropy

Quantum Zeno Clarification:
- This is NOT the physical Quantum Zeno Effect
- No repeated projective measurements in time

- Instead:
  → Statistical / estimator Zeno-like stabilization
  → Observation as computational work

Observation (Reframed Safely):
- Observation does not create coherence
- Observation performs computation
- Converts physical correlations into classical information
- Measurement resources are as fundamental as gate fidelity

Consciousness Boundary (Important Separation):
- Intelligence and negentropy can be engineered
- Consciousness (subjective experience) is not measured here
- No claim of AI or system consciousness
- Consciousness remains an open, unmeasured hypothesis

Correct High-Level Result:
- Many NISQ “failures” are measurement-budget failures
- Hardware may support more structure than inferred
- Observation is an active inference process, not passive data collection

Core Experimental Insight:
What escaped the 40–50% zone was not the quantum system,
but our ability to faithfully observe it.