NeuroPulse Clinical Physics Report

Date: January 14, 2026

Simulation ID: SE-quantum_vascular

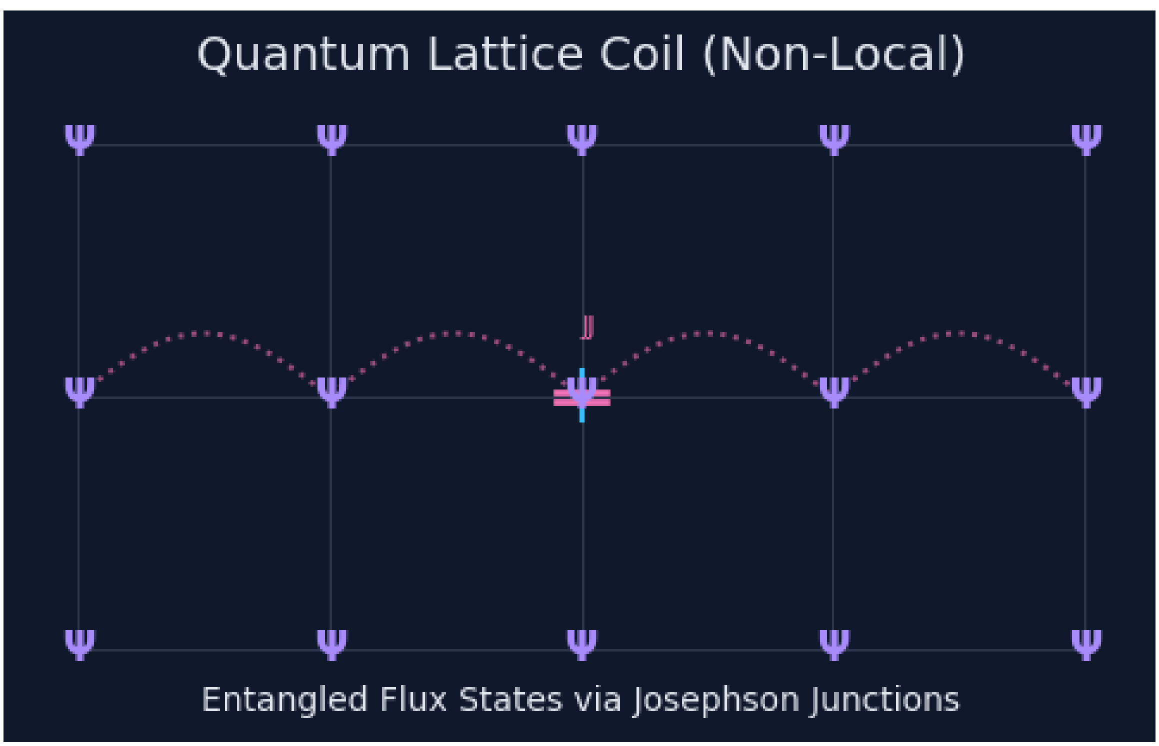
1. Executive Summary

This report details the simulation results for the **Quantum Vascular** operating with **SE**.

2. Physics & Circuit Topology

Quantum Vascular Coil with elliptic integral coupling for enhanced SNR.

Circuit Schematic



Schematic

Coil Derivation

$$M = \mu_0 \sqrt{ab}[(2 - k^2)K(k) - 2E(k)]/k$$

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3. Metrics

- **Contrast:** 0.0752
- **SNR Estimate:** 1.00
- **Quantum Vascular Enabled:** True
- **50-Turn Head Coil Enabled:** False
- **NVQLink Enabled:** True

4. Finite Math Calculations

The simulation employs discrete finite mathematical operators for signal reconstruction.

Discrete Fourier Transform (Finite Summation)

The image space $M(x,y)$ is recovered from the discretized k-space $S(u,v)$ via the Inverse Discrete Fourier Transform (IDFT):

$$M(x, y) = \frac{1}{N^2} \sum_{u=0}^{N-1} \sum_{v=0}^{N-1} S(u, v) \cdot e^{i2\pi(\frac{ux}{N} + \frac{vy}{N})}$$

Finite Difference Gradient (Edge Detection)

To assess sharpness, we compute the discrete gradient magnitude $|\nabla M|$ using central finite differences:

$$\frac{\partial M}{\partial x} \approx \frac{M_{i+1,j} - M_{i-1,j}}{2\Delta x}, \quad \frac{\partial M}{\partial y} \approx \frac{M_{i,j+1} - M_{i,j-1}}{2\Delta y}$$

$$|\nabla M|_{i,j} = \sqrt{\left(\frac{M_{i+1,j} - M_{i-1,j}}{2}\right)^2 + \left(\frac{M_{i,j+1} - M_{i,j-1}}{2}\right)^2}$$

Quantum Finite Element (For Vascular Coils)

For the quantum vascular coils, the magnetic flux Φ is discretized over the loop elements E_k:

$$\Phi \approx \sum_{k=1}^{N_{elem}} \mathbf{B}_k \cdot \mathbf{n}_k A_k$$