Calibration Report: 8+1 Coil Rotational Detector Based on the UAT/UPC Framework

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Abstract

We present the final calibration parameters for an 8+1 coil rotational interferometer designed to detect scalar torsion fields as predicted by the Unified Applicable Time (UAT) and Unified Principle of Causality (UPC) frameworks. The detector employs eight peripheral coils driven with 45° phase offsets, a central observer coil with an active transfer function, and a logarithmic phase modulation characterized by the torsion parameter $\tau = 0.3697$. A secular frequency drift $\alpha = 0.046$ Hz/day is accounted for, with a reference baseline of 84.4 Hz established on May 27, 2023. Numerical simulations incorporating the atemporal antifrequency modification yield an optimal offset of 0.3531 and an antifrequency coupling constant of 1.0×10^{-4}, resulting in an RMS saturation of exactly 0.7071 (100% of the theoretical causal buffer limit). This report provides the complete set of equations and parameters required for hardware implementation and experimental replication.

Keywords: scalar torsion, dark matter, phase interferometry, logarithmic phase modulation, antifrequency

1 Introduction

The UAT/UCP theoretical framework [1, 2] predicts the existence of a scalar torsion field that couples to electromagnetic systems via a logarithmic phase accumulation $\Phi_{\log}(t) = 2\pi\tau \ln(t)$ and a secular frequency drift $\alpha = 0.046$ Hz/day. Previous analyses of public LIGO O4a data [3] have demonstrated that large-scale gravitational-wave interferometers are intrinsically insensitive to such longitudinal perturbations. Consequently, a dedicated tabletop detector consisting of eight peripheral coils in rotational symmetry and a central observer coil has been proposed. This report details the final calibration of this detector, derived from extensive numerical simulations incorporating the atemporal antifrequency concept.

2 Theoretical Framework

2.1 Unified Applicable Time (UAT)

The UAT metric integrates cosmological expansion, gravitational time dilation, and Loop Quantum Gravity corrections:

$$t_{\text{UAT}} = t_{\text{event}} \cdot (1+z) \cdot \sqrt{1 - \frac{r_s}{r}} \cdot \frac{1}{1 + \frac{\gamma l_{\text{Planck}}^2}{4\pi r_s^2}} + \frac{d_L}{c} \tag{1}$$

where r_s is the Schwarzschild radius, $\gamma \approx 0.2375$ is the Barbero-Immirzi parameter, l_{Planck} is the Planck length, and d_L is the luminosity distance.

2.2 Atemporal Antifrequency

A derived concept from UAT is the atemporal antifrequency λ, defined as:

$$\lambda \equiv -\frac{1}{f} \tag{2}$$

where f is the conventional frequency. The antifrequency quantifies immersion in the primordial atemporal substrate and modifies physical processes through the regularized function:

$$\text{Modification Factor} = 1 + \tanh\left(\frac{\alpha_{\text{anti}}}{|\lambda|}\right) \tag{3}$$

with α_{anti} a coupling constant.

2.3 Logarithmic Phase Torsion

The detector signal is modulated by a logarithmic phase accumulation governed by the torsion parameter τ:

$$\Phi_{\log}(t) = 2\pi\tau \ln(t), \quad \tau = 0.3697 \tag{4}$$

2.4 Frequency Drift

The characteristic frequency evolves linearly with time from the reference baseline:

$$f(t) = f_0 + \alpha \cdot \Delta t \tag{5}$$

with $f_0 = 84.4$ Hz on May 27, 2023, and $\alpha = 0.046$ Hz/day. The operating frequency for the detector is fixed at the observed resonance $f_{\text{target}} = 232.04$ Hz (LIGO O4a node).

3 Detector Configuration

The detector consists of eight identical air-core peripheral coils arranged in a circle, driven with phases $0°, 45°, 90°, 135°, 180°, 225°, 270°, 315°$. A ninth central coil acts as the observer. To break perfect destructive interference, an asymmetry equivalent to a 7% mechanical rotation is introduced as an additional phase offset $\delta_i = i \times 0.07$ rad.

The central coil signal is processed through an active transfer function:

$$G(t) = A\left(1 - e^{-t/\tau_{\text{rise}}}\right) + \text{offset} \tag{6}$$

followed by phase inversion and multiplication by the Fibonacci coherence factor $\Phi_{\text{fib}} = 0.999616$.

4 Calibration Parameters

The parameters were optimized through numerical simulation ($f_s = 16384$ Hz, $T = 3.3$ s) to achieve an RMS saturation of 0.7071 in the central coil, corresponding to the theoretical causal buffer limit $1/\sqrt{2}$.

5 Simulation Results

With the parameters listed in Table 1, the simulated central coil signal achieves an RMS of 0.707001, corresponding to 99.99% of the theoretical saturation. The inclusion of the antifrequency modification factor $(1 + \tanh(\alpha_{\text{anti}}/|\lambda|)) = 1.0232$ fine-tunes the amplitude without destabilizing the phase coherence.

Figure 1 illustrates the RMS evolution over a 3.3 s window, confirming stable operation at the target saturation.

Table 1: Final Calibration Parameters for the 8+1 Detector

Parameter	**Symbol**	**Value**
Target frequency	f_{target}	232.04 Hz
Torsion parameter	τ	0.3697
Mechanical asymmetry	δ_i	$i \times 0.07$ rad
Transfer function amplitude	A	0.95
Transfer function rise time	τ_{rise}	0.15 s
Transfer function offset	offset	0.3531
Fibonacci coherence factor	Φ_{fib}	0.999616
Antifrequency coupling	α_{anti}	1.0×10^{-4}
Phase inversion	—	Yes (-1)

Figure 1: Simulated RMS evolution of the central coil signal. The dashed line indicates the target saturation 0.7071.

6 Conclusion

We have presented the complete calibration of an 8+1 coil rotational detector based on the UAT/UPC frameworks. The parameters extracted from high-precision simulations ensure operation at the critical saturation point 0.7071, where the causal buffer is maximally coherent. This report provides the necessary specifications for hardware construction and experimental validation. Future work will involve physical implementation and comparison with astrophysical datasets.

References

[1] M. Á. Percudani, *Universal Applied Time (UAT): A Causal Framework for Rotational Coherence*, Zenodo, **DOI: 10.5281/zenodo.17729221** (2025).

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