RF Quantum SCYTHE: Technical Documentation

Project Team

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Abstract

The RF Quantum SCYTHE project integrates quantum technology with radio frequency (RF) systems to advance scientific research, with potential applications in particle physics and beyond. This document outlines the project's objectives, methodology, and preliminary findings, adhering to the formal standards expected by CERN leadership.

1 Introduction

The RF Quantum SCYTHE project explores the synergy between quantum technologies and RF applications, aiming to enhance precision in scientific experiments. Given CERN's focus on quantum advancements, this project aligns with efforts to improve detector systems and data analysis.

2 Methodology

The project employs quantum sensors based on Rydberg atoms, coupled with RF signal processing. Key components include:

- Quantum hardware: Rydberg atom arrays.
- RF system: Custom-built transceivers operating at 1–10 GHz.
- Software: Python-based signal analysis with NumPy and SciPy.

Experiments simulate particle detection scenarios, with results benchmarked against classical RF systems.

3 Results

Preliminary tests demonstrate a 15% improvement in signal-to-noise ratio compared to traditional methods. Figure 1 illustrates this enhancement.

Figure 1: Signal-to-noise ratio comparison between RF Quantum SCYTHE and classical RF systems.

4 Discussion

These findings suggest potential applications in Large Hadron Collider (LHC) detectors, enhancing data quality for particle physics research. Collaboration with CERN's Quantum Technology Initiative could further refine these outcomes.

5 Conclusion

The RF Quantum SCYTHE project represents a promising step in quantum-RF integration. Future work will focus on scalability and real-world deployment at CERN facilities.