Retrofitting the Readout of a Large Interferometer in Washington

by

Nicolas de Mateo Smith

Submitted to the Department of Physics
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 2035

Author .....
Department of Physics
May 18, 2035

Certified by .....
Nergis Mavalvala
Professor
Thesis Supervisor

Certified by .....
Peter Fritschel
Principal Research Scientist
Thesis Co-supervisor

Accepted by .....
Somebody
Somebody

Retrofitting the Readout of a Large Interferometer in Washington

by

Nicolas de Mateo Smith

Submitted to the Department of Physics
on May 18, 2035, in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Abstract

The road approaching a direct detection of Gravitational Waves is long and hard, I am just one of many to walk this road. Here is my story.

Thesis Supervisor: Nergis Mavalvala
Title: Professor

Thesis Co-supervisor: Peter Fritschel
Title: Principal Research Scientist

Acknowledgments

This is the acknowledgements section. You should replace this with your own acknowledgements.

Contents

List of Figures

List of Tables

Chapter 1

Gravitational Radiation

Chapter 2

Experimental Efforts for Detection

Chapter 3

The Theory of Readout Retrofitting

3.1 Increased Input Laser Power

3.2 Non-modulated Signal Extraction

3.2.1 Optical SNR as Compared to RF Modulated Signal Extraction

3.3 Output Mode Cleaner

3.4 Squeezed Light Injection

Chapter 4

Performance of DC Readoud in Enhanced LIGO

4.1 Laser Noise Coupling

4.1.1 Numerical Model of Noise Couplings

4.1.2 Measurements of Noise Couplings

4.2 Optical SNR

Chapter 5

The Output Mode Cleaner

5.1 Optical Design

5.1.1 Optical Parameters

5.2 Mechanical Design and Seismic Isolation

5.3 Servomechanisms

5.3.1 Digital Control Systems

5.3.2 Cavity Length Control

5.3.3 Alignment Control

5.4 Noise Sources Introduced in the OMC

5.4.1 OMC Length Noise

5.4.2 Beam Jitter Noise

Sensitivity to Beam Motion

Sources of Beam Jitter

Chapter 6

The Great Success of the H1 Squeezer Project

Appendix A

Tables

Table A.1: Armadillos

Armadillos	are
our	friends

Appendix B

Figures

Figure B-1: Armadillo slaying lawyer.

Figure B-2: Armadillo eradicating national debt.

Bibliography