LEIDEN UNIVERSITY

MASTERS THESIS

Opto-Mechanical Design for a Single Laser Adaptive Optics System for METIS

Author:
Alex Tripsas

Supervisor:
Dr. Kelsey Miller
& Prof. Matthew Kenworthy
& MSc. Steven Bos

A thesis submitted in fulfillment of the requirements for the degree of Masters Thesis

in the

METIS Group
Astronomy and Instrumentation

May 30, 2020

Declaration of Authorship

I, Alex Tripsas, declare that this thesis titled, "Opto-Mechanical Design for a Single Laser Adaptive Optics System for METIS" and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed:

Date:

"Now is the moment that everything can change
You are completely responsible for your own life
And no one is coming to save you from yourself
So stop blaming your problems on any or everything else
It does not matter one tiny [obscenity] bit
How unfair you think the world is
It's only what you do
Right here, right now
Right this [obscenity] instant that matters
It's your choice to
Sink or swim"

D. Randall Blythe

LEIDEN UNIVERSITY

Abstract

Astronomy Department
Astronomy and Instrumentation

Masters Thesis

Opto-Mechanical Design for a Single Laser Adaptive Optics System for METIS

by Alex Tripsas

The first generation of instruments on the upcoming ELT all need to use adaptive optics to take advantage of the 39 meter aperture the ELT offers. While Laser Tomography AO provides better wavefront correction, it can be cumbersome and costly to implement a LTAO WFS. Previous research has shown that Single Laser AO could still provide sufficient wavefront correction for METIS. This thesis covers the process to design a cheaper alternative to the LTAO system planned for METIS. The designed optical layout has all spherical surfaces except for one aspherical surface, a telescoping mirror system for altitude correction, glass all made of the same material, and is compact ($1.2m \times 900mm \times 400mm$). The static optical system has a WFE of 0.0893 waves (52nm) RMS and 0.397 waves (233 nm) PTV .

Acknowledgements

I'd like to thank Dr. Remko Stuik for putting up with me twice a week and really driving me to fully understand what I was doing and teaching me many valuable skills.

Benjamin Arcier for all the work he did up until his graduation and continuing to be a great person to talk to afterwards.

To all my old colleagues back at University of California Santa Cruz for, despite me not being there anymore, to continue to help me. Notably, Will Deich and Rion Parsons, if it weren't for you, this research would have been a nightmare.

My long time friend Patrick Hoge, who helped me put together images that were outside of my Photoshop abilities. He will be cited where applicable

Lastly, Professor Bernhard Brandl for communicating with me even before I was officially a student and believing that I could bring something to this project with METIS.

Contents

List of Figures

List of Tables

List of Abbreviations

GMT	Giant Magellan Telescope
PSF	Point Spread Function
DM	Deformable Mirror
AO	Adaptive Optics
WFS	WaveFront Sensor

Dedicated to my friends and family who helped keep me going.

Chapter 1

Introduction

Contents:

Chapter 2

Mechanical Design of Initial Optical Design

Contents:

Chapter 3

Optical Design

Contents:

Chapter 4

Results of Optical Design

Contents:

Chapter 5

Conclusion

Appendix A

Wavefront Maps