Australian National University

System Subsystem Specification

Prepared For

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Acronyms

AITC Advanced Instrumentation and Technology Centre.

AO Adaptive Optics.

EOS Electro-Optic Systems.

GSL Guide Star Laser.

LGS Laser Guide Star.

OOS out of scope.

OPSL Optically-Pumped Semiconductor Laser.

SERC Space Environment Research Centre.

1 Scope

This section outlines the scope of this document, the context of the project, and the scope of the project. It also defines aspects of the system that have been deemed to be out of scope.

1.1 Document Scope

The scope of this document is to outline all of the requirements and constraints for the system interface as defined by the project scope.

1.2 Project Context

1.2.1 The Telescope

The Electro-Optic Systems (EOS) 1.8m telescope is currently used for satellite and space debris tracking at Mt Stromlo Observatory in Canberra. This telescope is also the site of the Space Environment Research Centre (SERC) project to build a demonstrator for Adaptive Optics (AO) space debris tracking.

1.2.2 Guide Star Laser Optics

In AO a Guide Star Laser (GSL) is required to produce a fake star in the atmosphere, which can be used to calibrate the telescope to atmospheric turbulence. This fake star is known as a Laser Guide Star (LGS). Using a GSL is the current optimum method of creating a light source with acceptable return photon flux and manoeuvrability to track fast moving objects such as satellites.

1.2.3 Adaptive Optics Projects

The Advanced Instrumentation and Technology Centre (AITC) is in the process of developing multiple AO systems for various projects, one of which is the SERC demonstrator for AO space debris tracking. They also have an invested interest in the demonstration of the Optically-Pumped Semiconductor Laser (OPSL) prototype, as it is predicted to be a cheaper and more effective product for AO systems around the world.

1.2.4 System Interface

AITC has expressed a preferential preliminary concept for the System Interface that would enable all three GSL solutions to be interfaced to the laser simultaneously. However, it has also been recognised that this may not be possible within the constraints of the 1.8m telescope and the three GSL systems. Note that simultaneous interfacing does not imply simultaneous propagation of the lasers.

1.3 Project Scope

The project scope is to define and provide the requirements to interface the commercial Toptica GSL, the EOS GSL, and the OPSL on the EOS 1.8m telescope located at the Mt. Stromlo Laser Ranging Facility, ACT. See Section **??** for further details.

1.4 Out of Project Scope

The capabilities/attributes defined to be out of scope (OOS) of the project objectives and deliverables for the Interface System are outlined as below:

a. Beam transfer optics from the laser to the laser launch telescope

b. Laser launch telescope

2 Interfaces and Constraints

2.1 Interfaces and Constraints Outline

The interfaces and constraints of the System that are within the definition of the Scope Statement section1.3 are outlined from a top level perspective in the Interface Tree FIGURE There are four major groupings of 1.1 interfaces with in the top level 1. System Interface, 1.1.1 Physical, 1.2 Electrical, 1.3 Optical, 1.4 Logical. The 2 Constraints of the project will affect the interfaces however they are not interfaces themselves. There is one group of constraints 2.1 Environmental. The number referencing system applied to the interfaces and constraints shall be utilised as the frame work to ensure all requirements are addressed in this document.

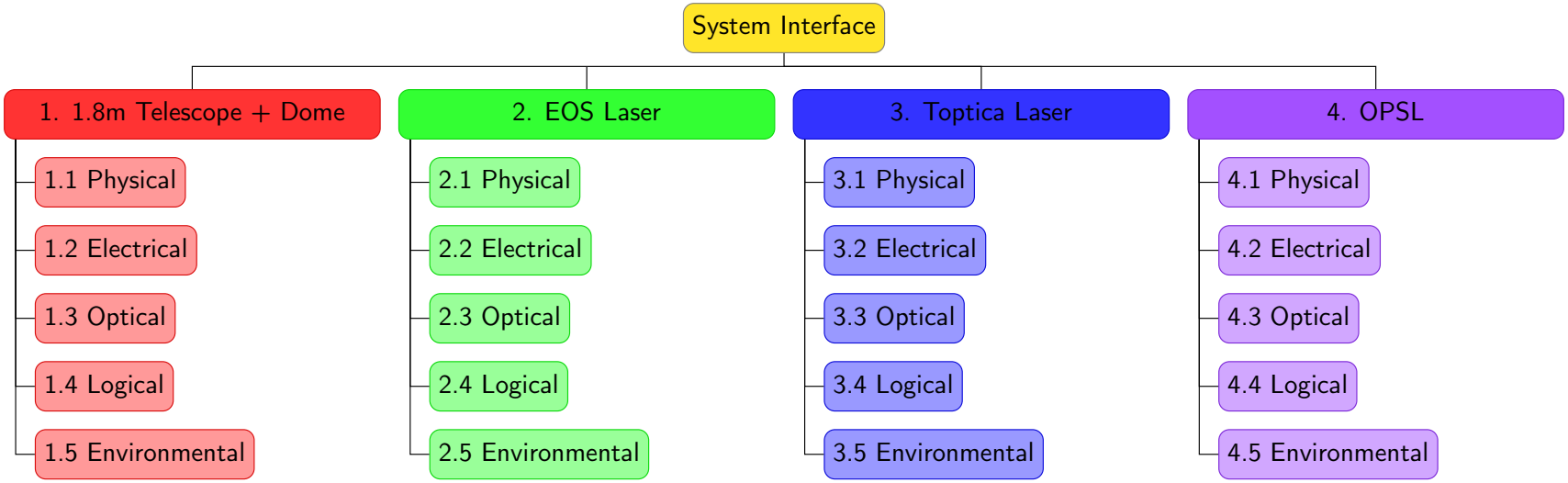

Figure 1: Interface Tree

3 Requirements and Constraints

3.1 Requirements and Constraints

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While the 1.8 Telescope and Toptica GSL systems are finalised the EOS, GSL and AITC are not. The requirements and constraints for the two incomplete systems shall still be developed. Any requirements numeric for these two systems that may be subject to change or have not been finalised are denoted with '$\sim$' to represent an approximate value.

3.2 Requirements Verification Matrix

The Requirements Verification Matrix TABLEREF shall provide a framework for verification of the system interface against the requirements and that each requirement is quantitative.
For each requirement or constraint with approximate numeric a notes will be placed in the comments section stating 'approximate' for rapid identification of finalised and non-finalised values.
The verification of each requirement shall be performed either by inspection (I), analysis (A), demonstration (D), testing (T) or a combination thereof.

Reference	Description	Verification				
		I	A	D	T	Comments
1.1.1	The System Interface shall not obtrude more than 1000mm from the 1.8 Telescope mounting position	×				
1.1.2	The telescope dome dictates that the System shall not extend more than 500mm above the 1.8m telescope's mounting plate on the left side	×				
1.1.3	The telescope dome dictates that 1000mm of space remains between The System and the wall, as a walkway.	×				
1.1.4	The telescope dictates that the System shall not place more than 225/FS MPA on any bolt in the telescope.					
1.1.5	The telescope dome dictates that the System shall not include any components with a cross sectional width greater than 3m	×				
1.1.6	The telescope dome dictates that the System shall not weigh more than 2000kg.					This is also a comment.
1.1.7	The telescope dictates that the System shall be mounted to the telescope using no more than the available holes.					
1.1.8	The telescope dictates that the System shall have peripheral electronics contained within a $3m^3$ space within 3m of the mounting plate.	×				
1.1.9	The telescope dictates that the System shall have peripheral electronics contained within a $36m^3$ space within 10m of the mounting plate.	×				
1.1.10	The telescope dome dictates that the System shall not impart a stress of over ? on the dome floor.					
1.1.11	The telescope dome dictates that the System shall require no more than 14 electrical sockets.	×				
1.1.12	The telescope dictates that the System shall be fixed to the telescope via the following parts: COM-T1252-1-ANU, COM-T1252-2-ANU, COM-T1245-1-ANU, COM-T1245-2-ANU.	×				

Reference	Description	Verification				
		I	A	D	T	Comments
1.2.1	The telescope dictates Sample Electrical	×				
1.3.1	The telescope dictates Sample Optical	×				
1.4.1	The telescope dictates Sample Logical	×				
1.5.1	The telescope dictates that the System shall account for external temperature variation of up to 28°C.					This is a comment.
1.5.2	The telescope dictates that the System shall account for vibrational input of total magnitude 2.2m/s^2.					
1.5.3	The telescope dome dictates that the System shall account for a dirty and dusty environment.	×				
2.1.1	The EOS GSL dictates that the laser be mounted on 3 breadboards.	×				
2.1.2	The EOS GSL dictates that the breadboards be 1800 × 800 × 100 mm (l×w×h).	×				
2.1.3	The EOS GSL dictates that the breadboards have a minimum of 250 mm space between them.	×				
2.1.4	The EOS GSL dictates that all three breadboards be mounted in the upright position.	×				
2.1.5	The EOS GSL dictates that all three breadboards be aligned vertically.				×	
2.1.6	The EOS GSL dictates that each board with optical components will weigh approximately 150 kg.				×	Approx.
2.1.7	The EOS GSL dictates that approximately one third of the central board will be free space.	×				Approx.
2.1.8	The EOS GSL dictates that the auxiliary electronics stack be 500 × 500 × 1750 mm (l×w×h).	×				
2.1.9	The EOS GSL dictates at least 10 power cables into the boards collectively.	×				
2.1.10	The EOS GSL dictates about 10 chiller pipes into the boards collectively.	×				Approx.

Reference	Description	Verification				
		I	A	D	T	Comments
2.2.1	The EOS GSL requires a single 240 V, 10A power socket (Australian Standard) to power the laser.				×	
2.2.2	The EOS GSL requires 4 standard power sockets to power 4 chiller units.				×	Approx.
2.2.3	The EOS GSL requires between 1 and 3 standard power plugs for the electronics stack.				×	Approx.
2.3.1	The EOS GSL dictates a final beam size between 10 μm and 5mm as required.			×		
2.4.1	The EOS GSL requires one Ethernet cord for control and maintenance.				×	
2.4.2	The EOS GSL requires one CAN bus for control.				×	Not currently implemented
2.5.1	The EOS GSL requires no special ambient temperature conditions.				×	
2.5.2	The EOS GSL dictates that one board will contain several beam dumps which will produce heat.	×				
2.5.3	The EOS GSL dictates that the central board will contain a peltiair box which will produce 10 to 20 W of excess heat.				×	
2.5.4	The EOS GSL requires that it is not exposed to vibration in over NUMBER m/s^2 in magnitude.				×	Approx.
2.5.5	The EOS GSL requires air quality of at least NUMBER ppm				×	Approx.
3.1.1	The Toptica GSL dictates that a physical dimension of 925(L) × 720(W) × 440(H) mm for the laser head is required.			×		
3.1.2	The Toptica GSL dictates that the System shall require additional space 930(L) × 910(W) × 1726(H) mm for the external electronics cabinet			×		
3.1.3	The Toptica GSL dictates that the System shall not separate the laser head and electronics cabinet by a physical cabling distance of more than 27 metres			×		
3.1.4	The Toptica GSL dictates that the System shall provide an operating temperature within 1.5°C of the ambient telescope dome ambient temperature					

Reference	Description	Verification				
		I	A	D	T	Comments
3.1.5	The Toptica GSL dictates that the system shall operate within temperatures of -10 to 20°.					
3.1.6	The Toptica GSL dictates that the System shall weigh at least 80kg.					
3.1.7	The Toptica GSL dictates that The System shall incorporate a 600kg electronics cabinet located no further away than 27m.		×			
3.1.8	The Toptica GSL dictates that a splice be included on the optical cable near the laser head.				×	
3.2.1	The Toptica GSL dictates that the System shall incorporate an uninterrupted power supply for 15 minutes of autonomous backup power.					
3.2.2	The Toptica GSL dictates that the System shall provide at least 700W of power up to a maximum of 2kW for the laser head			×		
3.3.1	The telescope dictates Sample Optical	×				
3.4.1	The Toptica GSL dictates one data cable for control and monitoring.				×	Possibly old info
3.5.1	The telescope dictates Sample Environmental	×				
4.1.1	The System Interface shall not obtrude more than 1000mm from the 1.8 Telescope mounting position	×				
4.2.1	The telescope dictates Sample Electrical	×				
4.3.1	The telescope dictates Sample Optical	×				
4.4.1	The telescope dictates Sample Logical	×				
4.5.1	The telescope dictates Sample Environmental	×				