Australian National University

Electrical Subsystem Design

Prepared For

Advanced Instrumentation and Technology Centre

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Acronyms

ANU Australian National University.

CAN Controller Area Network.

EC Electronics Cabinet.

EOS Electro-Optic Systems.

GSL Guide Star Laser.

OCS Observatory Control System.

1 Introduction

Electrical interface between the Australian National University (ANU) laser, EOS laser, and the telescope, includes the power supply and communication systems for ANU laser auxiliary cabinet, EOS laser auxiliary cabinet and 3 separate cooling systems.

In terms of the power supply system, although there are 2 EOS breadboards requiring 10 power cables in total with up to 2.4kw power, this power supply is already built into the auxiliary cabinet, with only a single power cable required for the cabinet. The size of the auxiliary cabinet is $l \times w \times h$ = 500mm×500mm×1750mm. Despite its smaller size ($l \times w \times h$ = 660mm × 660mm × 1300mm), ANU laser auxiliary cabinet is similar to EOS cabinet, requiring one standard main power line.

For the communication and control system, the control for EOS laser is already managed by the auxiliary cabinet, which is completed through a CAN bus. A second communications port, an Ethernet port, is present for maintenance. The ANU laser can be controlled by either Controller Area Network (CAN) bus over Ethernet, or standard Ethernet. Assuming that the heat exchanger can be remotely controlled by serial communication, we need an Ethernet to serial communication converter with at least 3 output ports to connect 3 heat exchangers to Observatory Control System (OCS).

2 Communications

This section details the communications subsystem, detailing how the components interact with each other, and what needs to be completed to ensure that the system can be remotely controlled.

2.1 Communication Requirement

Details of the communication system requirements are shown in table 1.

Table 1: Communication Requirements

Reference	Description
1.4.5	The telescope dictates that 3 free Ethernet connections to the EOS OCS are available within the telescope. 1 on the observation deck and 2 in the electrical cabinet on the entry floor.
2.4.1	The EOS Guide Star Laser (GSL) requires that one Ethernet cable be connected for engineering and maintenance [1] .
2.4.2	The EOS GSL requires that Ethernet communication with the EOS GSL be conducted using SSH command line protocol [1] .
2.4.3	The EOS GSL requires that CAN bus protocol be used for control [1].
2.4.4	The EOS GSL requires connection to the EOS OCS for control and monitoring [1].

Component	Communication
ANU laser Electronics Cabinet (EC)	1 Ethernet
EOS laser	1 Ethernet
EC	1 CAN
3 Coolers	3 Serial Control
Ethernet to CAN converter	1 Ethernet
Ethernet to serial converter	1 Ethernet

2.2 Communications System Design

On the entrance floor, there is an electrical cabinet relaying all communication signals (figure 1). Note that figure 1 only shows the allocation of devices on each floor, but does not reflect the actual size and space requirements for each component. The cables connecting the EOS auxiliary electronics cabinet with the OCS have to go through the cable wrap in the dome. The cable length for this is approximately 40m, as seen in figure 4 in appendix A.

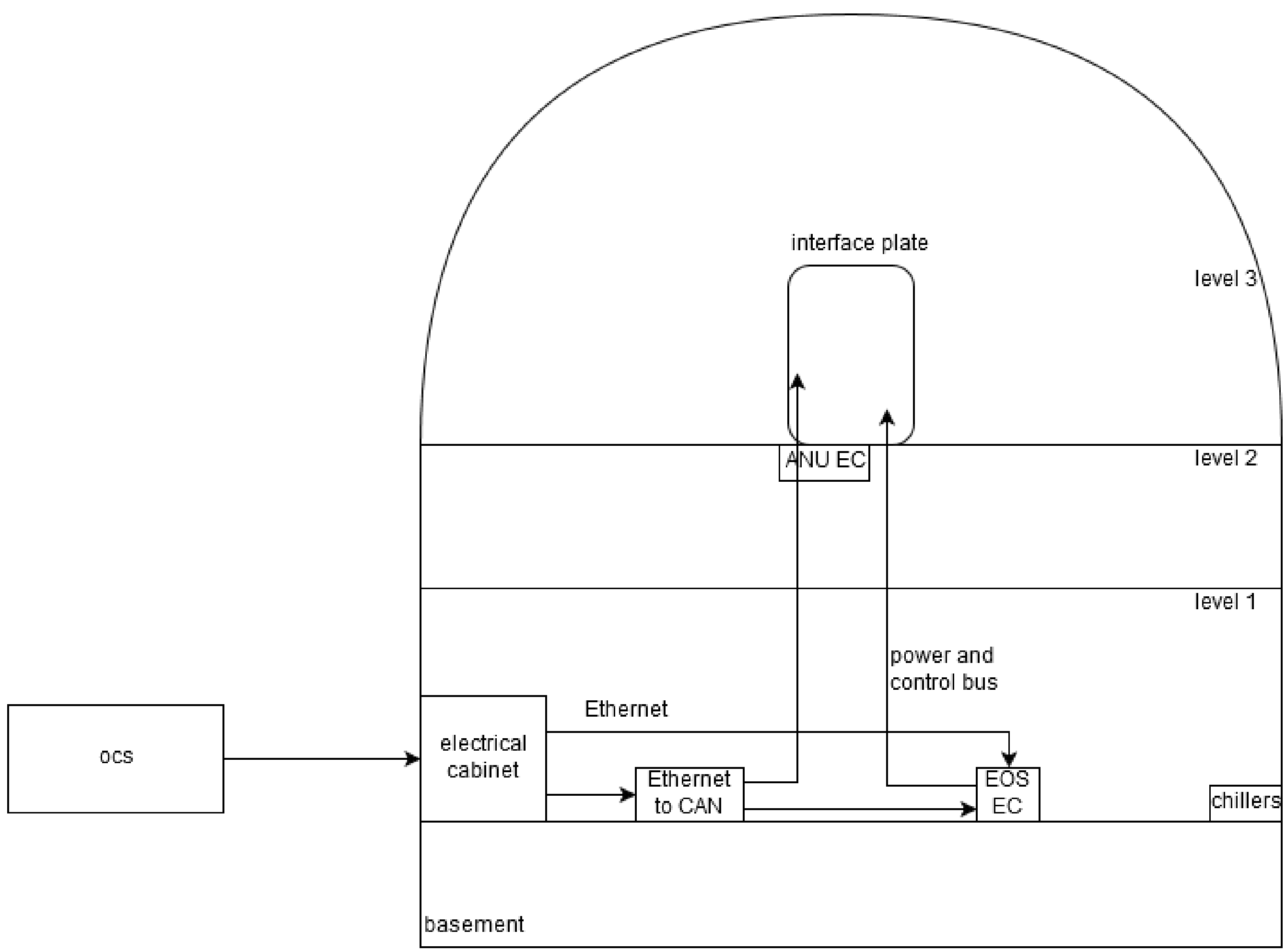

Figure 1: Horizontal View

As copper wires tend to intertwine from deformation, such as that caused by the cable wrap, a special envelope is used to cover those wires. Therefore, adding new cables connecting OCS and the cabinet on level 1 is costly and thus should be avoided. EOS laser communication requires a CAN bus for control but there is no CAN bus yet deployed between OCS and telescope. The best way to implement this is to convert one of the Ethernet into CAN bus.

The EOS EC height is 1750mm, which is too large to place on top of the workbench on the top floor. The proposed solution to this is restructuring the auxiliary cabinet so that it is placed in two stacks, side by side, or to relocate it onto the entrance floor.

Ethernet to CAN convector and EOS EC each requires a standard power socket. The chillers also require power socket each, however placement of these has not been finalised, as vibration sensitivity of the systems must first be established.

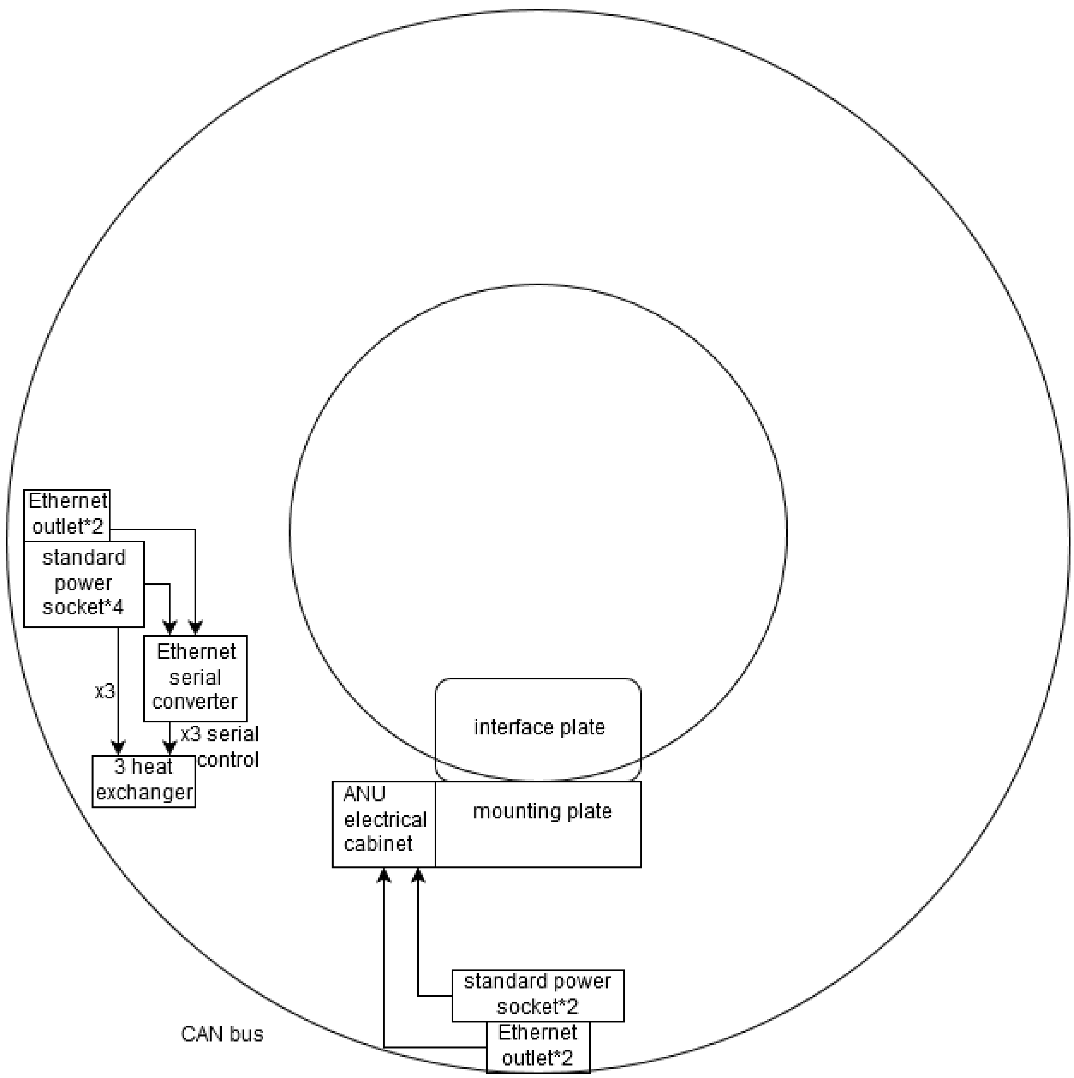

Figure 2: Overlook of top level

Figure 2 shows the spatial set-up of the electrical connections on top floor. The ANU laser is located beneath the enclosure, as there is a 2m upper limit for cabling between the laser head and the cabinet [2].

The cooling devices are remotely controlled by serial communication. In the event that heat exchangers are utilised, which is one of the 3 possible cooling configurations [3], the heat exchangers will need to be connected to serial lines converted from single Ethernet lines. The specification of the connections between the EOS electrical auxiliary cabinet and breadboards are shown in figure 3. Unfortunately, because the AUN laser electrical cabinet is still under development, the connection between ANU laser and the auxiliary cabinet is not specified.

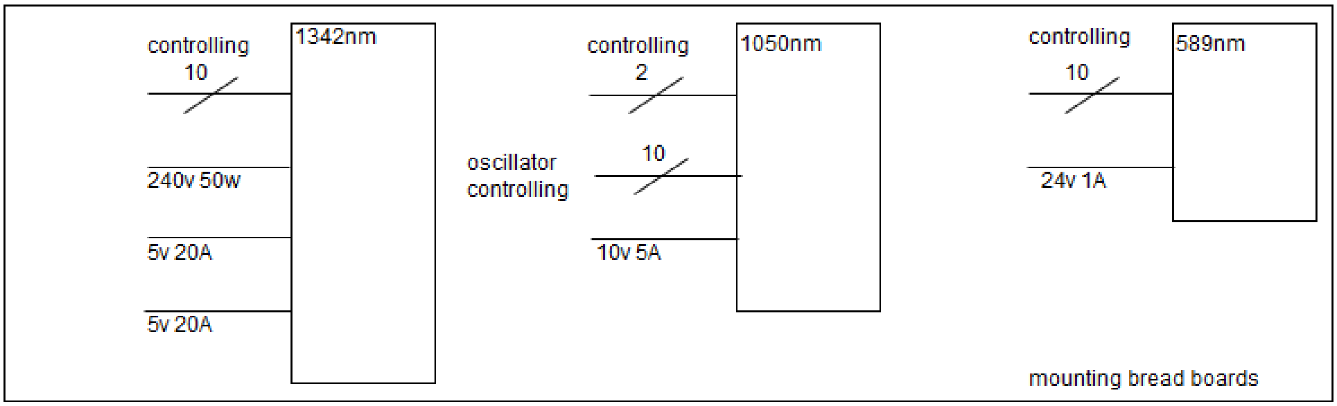

Figure 3: EOS Auxiliary to Breadboards cables

3 Power Draw

The requirements for the power of the system are detailed in table 2.

3.1 Power Requirement

Table 2: Power Requirements

Reference	Description
1.2.3	The telescope dictates that the System shall require no more than 6 standard electrical plugs (240 V, 10A) on the top floor of the telescope.
1.2.5	The telescope dictates that the System shall require no more than 8 ~~6~~ standard electrical plugs on the first floor of the telescope.
2.2.1	The EOS GSL requires 2.4kW of power via a standard single phase (230V / 10A) power socket [1].
2.2.3	The EOS GSL requires 1 + 1 power plugs for chillers or oscillator. If the latter is in the clean room, 1 standard power plug for the EC in dome. [1].
3.1.5	The telescope dictates that the ANU GSL be connected to a power supply via 1 standard power socket [4].
3.2.1	The ANU GSL requires less than 800W of cooling [4].
3.3.1	The ANU GSL requires approximately 800W of power for the auxiliary electrical cabinet

Table 3 details the expected power draw of each component. Details will require updating as additional information becomes available.

Table 3: Power Requirements

Source	Draw
EOS Laser Auxiliary Electrical Cabinet	< 2400W
EOS Laser Cooler	< 1500W
ANU Laser Auxiliary Electrical Cabinet	800W
ANU Laser Cooler 1 & 2 (Combined)	< 3000W
Enclosure Environmental Control	< 100W
Total	7.8kW

The power supplied to the telescope is 80A, 3-phase [5], giving an available power of approximately 32kW. The combined system draw is slightly under 25% of the available power, however the two lasers are not likely to be running at full power concurrently, indicating a much lower power requirement for the system.

The power can be validated further by establishing the full power draw of the active components within the dome, and ensuring that there is no possibility of exceeding the available power.
The power cabling requirements for the system, as seen in table 4, are less than the available sockets, indicating that the system is currently viable.

Table 4: Power Socket Requirements

ANU laser EC	EOS laser EC	3 coolers
1 main power	1 main power	3 main power

References

[1] N. Herald, “Personal Communication 24/03/17.”

[2] G. Fetzer, “Personal Communication 22/09/17.”

[3] “Environmental subsystem design,” October 2017.

[4] C. d’Orgeville, “Personal Communication 24/03/17.”

[5] A. Gray, “Personal Communication 7/10/17.”

A Cable Routing

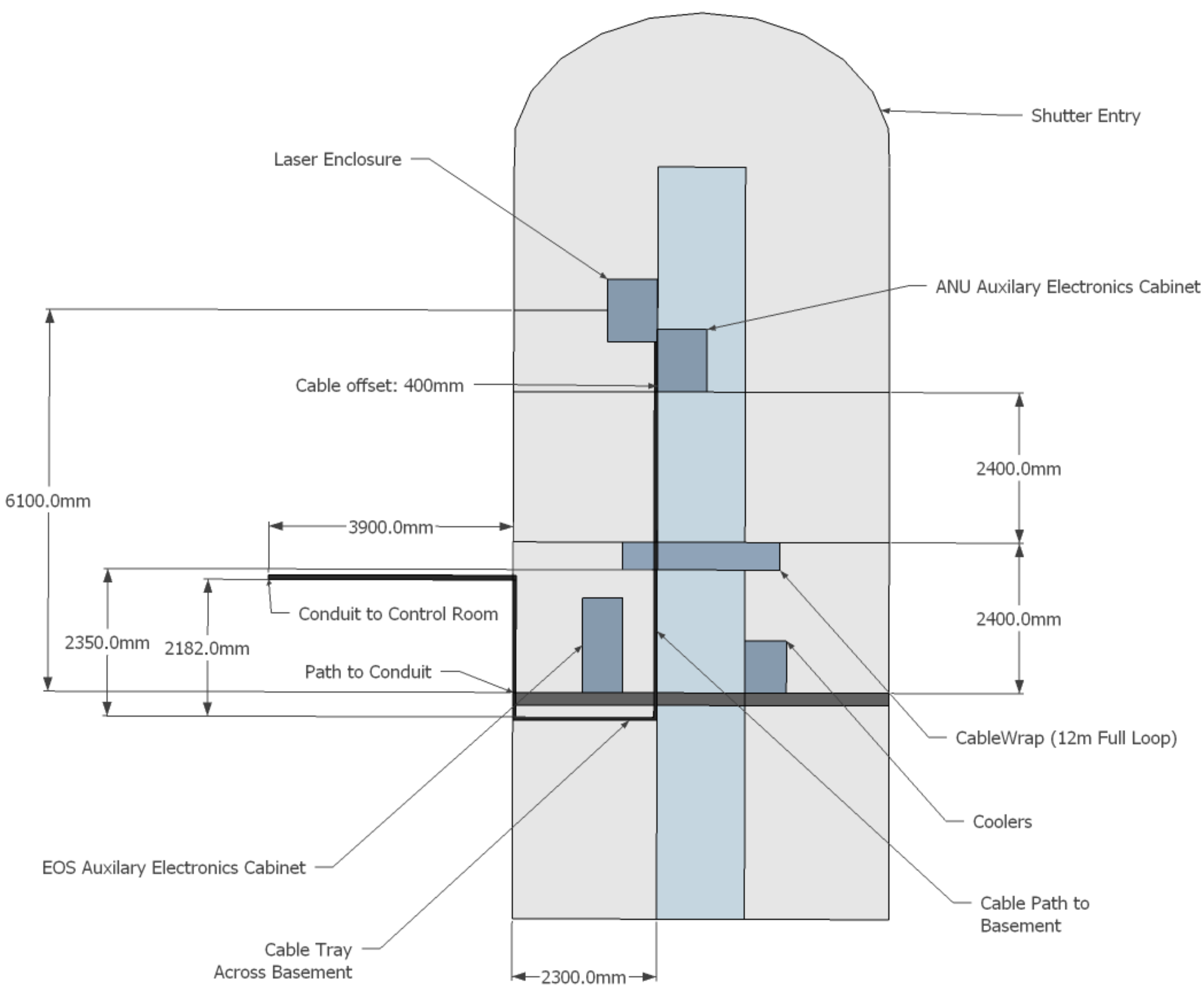

Figure 4: Cable Routing Diagram