KAON #756

Next Generation Adaptive Optics System

Laser Guide Star Facility Aircraft Safety and Detection System

Preliminary Design

May 07, 2010

VersionV1.0

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REVISION HISTORY

Revision	Date	Author (s)	Reason for revision / remarks
1.0	May 07, 2010		Initial release

TABLE OF CONTENTS

1 INTRODUCTION

As part of the Next Generation Adaptive Optics System (NGAO), a Laser Safety System (LSS) is needed to ensure the laser facility operates safety and in accordance with regulatory standards for operating a laser. These standards include the American National Standards Institute (ANSI) Z136.1 Safe Use of Lasers and Z136.6 Safe Use of Lasers Outdoors. The standards are to ensure safety for internal personnel and equipment, as well as external assets such as aircrafts and space vehicles. This document focuses on one aspect of the safety system, Aircraft Safety and Detection System (ASDS). At the end of the document, it will provide some insights into possible future aircraft safety upgrades.

2 REFERENCES

2.1 Referenced Documents

Documents referenced are listed in Table 1. Copies of these documents may be obtained from the source listed in the table.

Ref. #	Document #	Revision or Effective Date	Source	Title
1	KAON 510	1.0	WMKO	NGAO Risk Assessment
2	KAON 753	1.0	WMKO	Safety System ICD
3	ANSI Z136.1		ANSI	Safe Use of Lasers
4	ANSI Z136.6		ANSI	Safe Use of Lasers Outdoors

Table 1: Reference Document

2.2 Acronyms and Abbreviations

Table 2 defines the acronyms and abbreviations used in this document.

Acronym/Abbreviation	Definition
AAA	Auxiliary Amplifier Assembly
ANSI	American National Standards Institute
ASDS	Aircraft Safety and Detection System
FAA	Federal Aviation Administration
KAON	Keck Adaptive Optics Note
LSS	Laser Safety System
NGAO	Next Generation Adaptive Optics System
OEI	Optical Electronics Incorporated
PLC	Programmable Logic Controller
TIU	Telescope Interface Unit
WMKO	W.M.K. Observatory

Table 2: Acronyms and Abbreviations

3 METHODOLOGY

Since both Keck I and Keck II have aircraft system implementation in place, the NGAO will follow existing operational protocols for aircraft safety. The main requirement is that laser beam will be shutter when an aircraft enters the propagation hazardous zone. The major difference is that NGAO will be propagating in an asterism of lasers within a cone volume versus single laser beam as it is currently done in Keck I and II.

The existing ASDS for Keck I and II uses a combination of aircraft spotters and a boresight camera for detecting aircraft. The spotters are determined as tier 1 engineering control and are required by the FAA while the boresight camera is a tier 2 engineering control and is not required. Keck I does not have a boresight camera. When a spotter sees an aircraft in the beam vicinity, a large mushroom button is pressed to shutter the beam out of the telescope. Since the NGAO system is going to be in Keck II, the boresight camera will be left as an option to be included in the NGAO safety system; but it is not required. From an engineering point of view, the NGAO system will need to interface with the existing system or the interfaces must be modified to comply with the NGAO system.

Administratively, the request for "No Objection" must be submitted to the FAA Western Regional Office. The existing approvals must be resubmitted every year; therefore, the NGAO submittal will be done in place of the existing Keck II laser. WMKO will send a "Notification to Conduct Outdoor Laser Operations" to FAA during the DD Phase. This package will include data on WMKO's operational procedures, laser performance specifications, and safety mechanisms. The Laser Safety Officer is responsible the existing submissions and will be responsible for the NGAO request for "No Objection." Examples of the submission letters can be found on Keckshare: http://keckshare.keck.hawaii.edu/engineering/AdaptiveOptics/K2Laser.

4 DESIGN

The designs presented will focus on the engineering changes needed for the existing system to interface with the NGAO safety system to support aircraft safety.

4.1 Electrical

The existing interface to the Spotters Equipment for the Keck II LSS is shown in Figure 1. A panel is located in the dome floor laser room to interface with the spotters' equipment for shuttering the laser beam. The signals ties into the Keck II LSS Controller (Modicon) on the lower left of the figure. In the NGAO system, the Modicon Programmable Logic Controller (PLC) will be replaced by an Allen Bradley SLC500 PLC. The new PLC will be located in the AO electronics vault instead of the dome floor. To integrate the spotters unit, the panel will be moved to the Keck II computer room. The dome floor laser room will be dismantled during the K2 laser removal process. The NGAO safety system has been design to provide a single connection point for interfacing with signals off the telescope in the computer room.

The off-the-telescope signals will include laser status, facility emergency stop controls, and the spotters' interface. A new interface unit similar to the Keck I Telescope Interface Unit (TIU, Figure 2) will be fabricated and located in the Keck II computer room. Drawings for these units and cabling already exist from the Keck I LSS.

If the boresight camera capability is to be maintained, the Optical Electronics Incorporated (OEI) video processor for aircraft detection must also be moved. The processor is currently located on the dome floor laser room. Since the camera is located on the telescope, it is more reasonable for the video processor control signal to be located in the AO electronics vault as part of the Safety System PLC assembly.

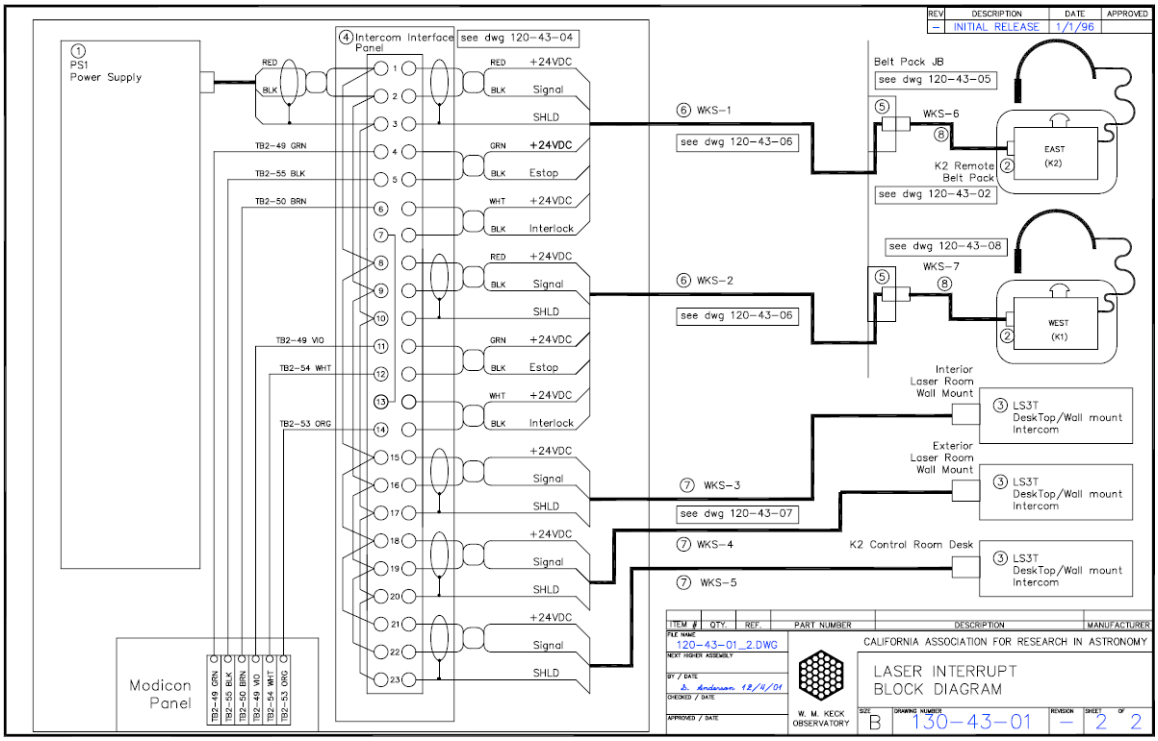

Figure 1: Keck II LSS Aircraft System Interface

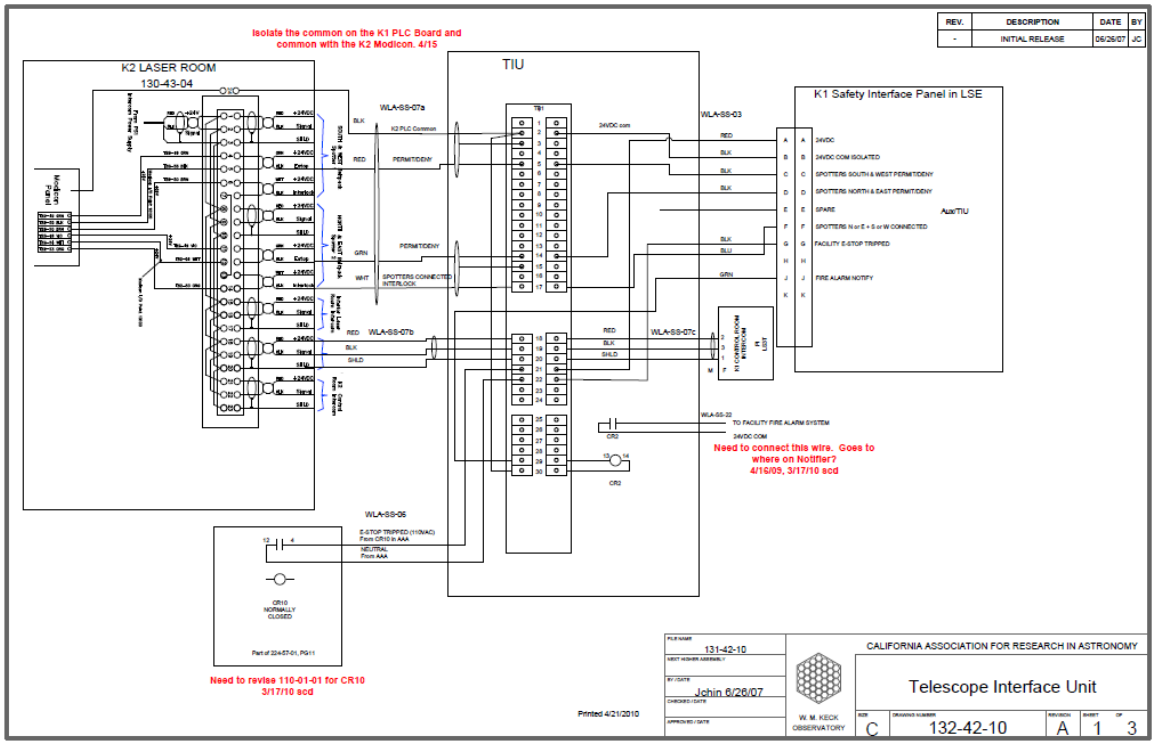

Figure 2: Keck I LSS Telescope Interface Unit (TIU)

4.2 Mechanical

No major mechanical work is needed other than mounting of the new TIU and aircraft interface panel. The panel and TIU will be located in the computer room which is temperature controlled. The current and new interfaces are passive devices and will not produce sufficient heat to be an issue. The current Auxiliary Amplifier Assembly (AAA) cabinet in the Keck II computer room has sufficient volume to support the new interfaces. The new units are expected to consume a surface area of 19" x 12". The boresight camera video process is a standard 19" rack mounted unit and will not require any additional mechanical modification for mounting in the AO electronics vault.

4.3 Software

No additional software is needed. All aircraft related software is the responsibility of the NGAO control software system and the LSS

4.4 Procedures

Existing operational procedures and manuals will be applicable. The relocation and additional interfaces will not change the functionality of the existing Keck II system.

4.5 Interfaces

The ASDS will provide the signals in Table 3; these signals are also included in KAON 753. These signals will be outputted to the Safety System PLC in the AO electronics enclosure. Each spotters unit will provide two signals, one to ensure the unit is connected and the second signal to represent aircraft detection. The OEI video processor provides two contact relays to the safety system. One will represent the health of the boresight camera by detecting NTSC video sync and the other will represent if an object is detected by the boresight camera. The relays are normally closed. If there is no video sync or an object is detected, the relay will be opened. These signals will be represented by the Safety System PLC and sent to the NGAO control software.

#	Signal	Type	Description
1	Boresight Camera/Processor Detection	Input	24VDC = No Detection
2	Boresight Camera/Processor Operating	Input	24VDC = Operating
3	East Spotter Connected	Input	24VDC = Connected
4	East Spotter Activated	Input	24VDC = No Detection
5	West Spotter Connected	Input	24VDC = Connected
6	West Spotter Activated	Input	24VDC = No Detection

Table 3: Aircraft Detection Interface

5 DELIVERABLES

The following chart shows the deliverables for the ASDS.

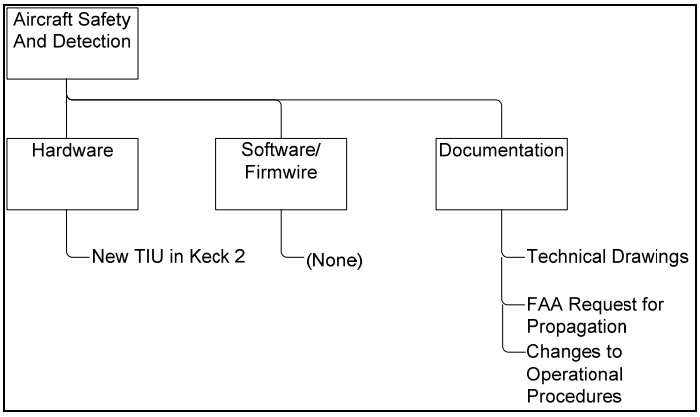

Figure 3: Aircraft System and Detection System Deliverables

6 DEVELOPMENT AND TESTING

The new hardware and relocation will occur during the Delivery and Commissioning phase after the Keck 2 laser is taken offline. Testing will be included as part of the PLC compliance testing. Subsequently the system will be verified as part of the preventative maintenance interlock testing.

7 WMKO AIRCRAFT DETECTION UPGRADE

WMKO is currently collaborating on a system using aircraft transponders and existing commercial software for aircraft notification in the area. WMKO is leading the effort in the removal of having physical spotters at the summit to support laser operations on Mauna Kea. The cost of spotters is a significant cost of operating a Laser Guide Star Adaptive Optics System. This new system is being fielded in FY10 to provide sufficient data to the FAA to consider the no-spotter option. More updates will be provided by the detailed design phase. If the system successful, the interface will be similar to the current design. The boresight camera input will be replaced by this transponder system and there may be no requirement for the spotters' hardware. The relative cost of this transponder system will be small compared to a boresight camera system and will likely be part of an operational upgrade rather than NGAO.

The All Sky Camera has also been considered as a possible replacement for spotters. However, completion of the system as well as reliability has not been shown. If it does become successful, the interface will be through software and will not require a hardware interface.

8 MANAGEMENT

Management information regarding cost and schedule is provided in the NGAO overall planning.

8.1 Risk Assessment and Reduction Plan

Based on the risk guidelines of KAON 510, the risks associated with the LSS as a whole is low. Implementation of a new boresight camera may be a risk due to the fact this unit is no longer available; however, since it is not required by the FAA and is not likely to be replaced in the event of a failure.

9 PLANS FOR THE NEXT PHASE

The following effort is planned for the Detailed Design Phase:

- Completed drawings for the new hardware
- Provide relocation plan for the existing hardware
- Ensure test plans are included in the overall safety system planning
- Spares Recommendation
- Updated budget and schedule