Keck Adaptive Optics Note 836

Near-Infrared Tip-Tilt Sensor Camera to Keck Adaptive Optics Interface Control Document

P. Wizinowich, R. Smith
March 10, 2011

Document Revision History

Revision Number	Revision Date	Summary of Changes	Author
1.0	11/19/2010	SDR Version	P. Wizinowich
1.1	12/16/10	Sect. 5 edited to better reflect NIR TTS system	P. Wizinowich
1.2	1/20/11	Edits to sections 4.3 & 4.5	A. Cooper
1.3	1/20/11	Edited sections 2.2, 4.1, 4.3, 4.4 & 4.5 based on 1/20/11 discussion.	P. Wizinowich
1.4	2/23/11	Updated Fig. 1 to transfer field lens, fold mirror & interface plate to Caltech. Edited section 2.2 to have Caltech provide the kinematic mounting plate & to better define the mechanical interface and allowable volume. Edited section 4.1 to reference the keyword spreadsheet. Edited section 4.2 to just require FITS images and to include a time stamp accuracy of 1 sec. Edited section 4.5 for the new compressor location and WMKO role.	P. Wizinowich
1.5	3/10/11	Sections 5.1 to 5.9 edited to be specific to the camera interfaces. This section had been a more generic Appendix.	J. Cromer
1.6	3/10/11	Added dimensions from R. Bartos to sections 2.2 & 4.4. Added a sealing mechanism interface requirement to section 2.2.	P. Wizinowich

Table of Contents

1. Introduction

This Interface Control Document (ICD) is written in support of the NSF ATI-funded near-infrared (NIR) tip-tilt sensor (TTS) project. The purpose of this document is to document the interfaces between the NIR TTS camera to be built at Caltech and the remainder of the NIR TTS system including the existing Keck AO system. The remainder of the NIR TTS system includes 4 additional subsystems: the opto-mechanical system, the real-time control system, the controls system and the operations software. A block diagram showing all 5 subsystems and their key components is provided in Figure 1. The overall system requirements and the functional requirements for each of the 5 subsystems can be found in the System Design Manual (SDM); these requirements are not repeated here.

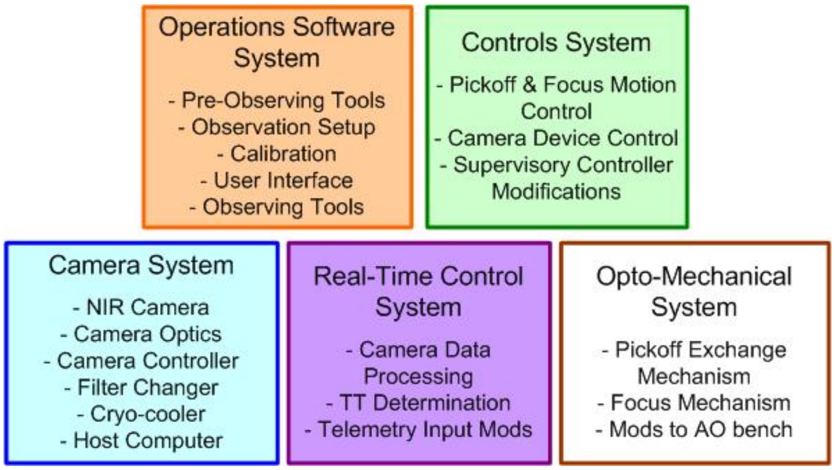

Figure 1: Major subsystems of the NIR TTS and their key components

The NIR TTS camera (i.e. the camera system in Figure 1) is defined as the cryogenic dewar enclosing the NIR detector and all items in this dewar, including optics and motion control, as well as the closed cycle refrigeration system, that keeps the dewar cold, the camera housekeeping and readout electronics and the camera's host computer.

2. Interfaces to the Opto-mechanical System

2.1 Optical Interface

The camera will be located in an f/13.66 beam at the science output of the AO system (f/13.66 is the 149.583 m focal length of the telescope divided by the 10.949 m diameter circumscribed circle enclosing the primary mirror). The telescope pupil will be located 19.948 m in front of the focal plane. The opto-mechanical system will include the part of the camera optics, if any, outside of the camera dewar. The 120" diameter field of view that the camera optics must transmit corresponds to 87 mm at the AO focal plane that feeds the NIR TTS.

2.2 Mechanical Interface

The camera shall mount kinematically to a Caltech provided plate. The bolt hole pattern to mount the Caltech kinematic plate to the WMKO provided system (a focus stage and riser) is defined in a TBD drawing of the Caltech provided plate.

The distance from the optical axis of the field lens in the Caltech camera to the bottom surface of the Caltech kinematic mounting plate is 95.25 mm to within 0.25 mm (note that the optical axis is located 305 mm above the AO bench and the AO bench cover is located 711 mm above the AO bench).

The maximum allowable envelope (TBC) for the camera system that sits on the WMKO supplied focus stage, is defined as follows:

- The camera shall not extend toward the pickoff optics by more than 50 mm in front of the front surface of the field lens.
- The camera shall not extend away from the pickoff optics by more than 400 mm behind the front surface of the field lens.
- The camera shall not extend to the left or right of the field lens optical axis by more than 200 mm from the optical axis.
- The camera shall not extend above the field lens optical axis by more than 600 mm.

The camera shall include a sealing mechanism for the hole through the AO bench top cover that is capable of handling 20 mm of focus travel.

3. Interfaces to the Real-time Control System

An interface must be provided between the camera readout electronics and the Microgate real-time control system to provide the high speed data needed to compute tip and tilt. This interface is defined in the Microgate statement of work (KAON 824).

4. Interfaces to the Controls and Operations Software Systems

4.1 Device Control and Monitoring Interface

See section 5 for details of control methods, interfaces and signal type.

The camera must provide a keyword software interface to support monitoring and control. An Ethernet interface must be provided to allow this interface.

The allowed control functionality must include power on/off, startup, shutdown, integration time, region of interest control, number of readout samples, start of integration and filter selection. The allowed diagnostics must include health monitoring including internal (dewar) temperature monitoring and control. The complete definition of the camera keywords is maintained in a configuration controlled excel spreadsheet (KAON 857); this KAON contains the official list of camera interface keywords that are required to be provided.

4.2 Acquisition Interface

The camera interface must provide full frame images in FITS format.

Camera exposure time and binning control should be available.

All images will contain time stamps at the UT when the shutter opened with 1 sec or better accuracy, provided by the clock within the TRICK host which is to be slaved to a time server TBD over Ethernet using the Network Time Protocol (NTP).

4.3 Electrical Interface

The maximum cable length between the camera and the camera electronics is 1.5 to 2.0 m for noise reasons. The cabling between the camera and the camera electronics must be at least 1.5 m long to allow locating of the electronics off of the AO optics bench.

The camera power supply will be located in the AO electronics room. The required cable length between the power supply and the camera electronics will be 7.5 m to 12 m (TBC) depending on the cable route.

Power to the camera power supply will be provided by an AC power cord. An AC power control switch must be provided to support switching of the camera power by commands sent over Ethernet.

The camera electronics should properly recover from any power interruption. Design features should be incorporated to insure the control electronics do not latch into an inoperable state due to power glitches or brownouts.

Temperature control will be provided by a Lakeshore controller mounted in the AO electronics room.

The camera host computer will be mounted in an electronics rack in the Keck I computer room. WMKO-provided fiber cables will be provided from the AO electronics room to the Keck I computer room. Caltech should supply fibers of sufficient length to reach a patch panel (2 fibers), and to reach the real-time controller (1 fiber), in the AO electronics room. The required fiber length is between 7.5 m and 12 m (TBC). An option exists to mount the camera host computer in the existing AO wavefront controller rack if this proves to be necessary.

4.4 Camera Electronics Cooling Interface

The camera electronics shall be housed in a WMKO-provided thermally insulated enclosure, separate from the camera, since the allowable cable lengths are too short to reach the AO electronics room. The thermally insulated enclosure will be air cooled via a hose to the existing air-to-glycol heat exchanger.

The interior of the thermally insulated enclosure must be large enough to accommodate the 349.25 x 139.7 x 171.45 (height) mm Caltech-supplied ARC camera electronics.

The camera power supply and Lakeshore temperature controller will be housed in the AO electronics room.

4.5 Cryogenic Interface

Two compressed gas lines will be run from the Joule Thompson (low vibration) cooler embedded within the camera to the compressor located in the K1 AO electronics room (the line length will be < 50 feet).

WMKO will provide vibration isolation for the compressor and will provide any required safety features external to the camera and cooler systems.

Due to quick cool down times (< 1 hr?) of the cryogenic cooler, it may be desirable to implement remote power control of the compressor. Allowing operation of the cryogenic system only when needed will reduce run time and maintenance on the compressor and reduce power usage of the system.

The Brooks PCC Compact Cooler provides no electrical interface, requiring only 500W of single phase AC power. Beyond cold head temperature, any other additional monitoring would have to be designed and added.

5. Control Method/Interface/Signal Type

This section discusses the various signals and types of control that were identified in the section above and how these will be connected to the Ethernet.

5.1 Remote Power Control

The largest classification of control is simple on/off of 120 VAC devices. Remote control of the power to individual devices has proven extremely valuable in the existing AO, Laser and Interferometer systems.

This function will be accomplished primarily through COTS devices. Suggested device is the Pulizzi ICP3402-NET eight-outlet power controller for the NIR TTS camera and associated controllers. This unit connects directly to the network, can be controlled via browser, telnet, or custom API and host server software already exists to interface to it.

No custom power control solutions using relays or digital I/O are anticipated.

5.2 Camera / Detector Control

Control of the NIR TTS camera shall be done over Ethernet through a host computer, running KTL-compliant servers and connected to the ARC Camera control electronics via a fiber optic pair. The network interface will use Keck standard keywords through the KTL API. The host-ARC electronics interface is done with three-letter ASCII commands and parameters over fiber optics. A separate fiber optic channel will be used to send image data to a real-time computer for processing.

5.3 Discrete (Digital) Input/Output

No separate digital I/O requirements are anticipated for the NIR TTS camera subsystem.

5.4 Analog Input

No separate analog inputs are anticipated for the NIR TTS camera subsystem.

5.5 Analog Output

No separate analog outputs are anticipated for the NIR TTS camera subsystem.

5.6 COTS Controllers

A number of off the shelf controllers will be required to provide monitoring/control of the environment and camera dewar.

A Lake Shore 340 temperature controller is suggested for control and monitoring of dewar temperatures.

For pressure monitoring, the controller is still TBD. Both the Granville Phillips Microlon Plus and the Edwards Active Digital Controller, D395-91-000 have been suggested.

The NIR TTS filter wheel will require a commercial motion controller and encoded motor. At this time, this controller is TBD. Galil controllers have been suggested.

5.7 Remote Reset Control

The ARC camera electronics provides the capability to reset the electronics without power cycling the entire assembly. This is done over the fiber-optic link using a custom ioctl control code to the system.

5.8 Video

No analog to digital/network video requirements are anticipated.

5.9 RS-232 and USB

The Lake Shore 340 requires an RS232 interface for remote control. It is likely that the pressure monitoring and motion-control hardware will also require serial connections. Lantronix terminal servers are currently being used in our lab and on the summit at Keck and one is recommended for this application.

5.10 Ethernet

Devices will connect to the Ethernet via a managed switch. Managed switches allow creation of 'V-LANs' that help route network traffic and optimize data flow. Currently HP products are used.

5.11 Time Distribution / Synchronization

Existing observatory infrastructure distributes a GPS time signal via the IRIG-B protocol. Each system requiring a UTC reference makes use of a local VME decoder board. This method is capable of delivering microsecond level accuracies, if care is taken to account for propagation delays in the cabling. Components with relaxed requirements, generally servers and PCs, use the Network Time Protocol (NTP) to synchronize their local clock. It is not clear if this is done at any time other than boot-up, so the initial millisecond level accuracy degrades rapidly. It is also not clear how the local NTP server is synchronized to UTC. [Note: NTP is adequate for the camera system]