NICI Top Level Interface Requirements

NICI System Design Note # SDN1002

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1.0 Introduction

This document will specify the top-level functional requirements of the NICI instrument interface to the Gemini systems. This document will ignore the method by which the interface is accomplished and focus on the interface requirements. An ICD will be written that specifies the method of interface for each of the requirements listed here. This document will be used by software and hardware engineers as a basis for a more detailed specification of these interfaces.

2.0 Interface Overview

In order for NICI to function as a Gemini Facility Instrument a variety of information must be passed between NICI and the Gemini software/hardware systems. This information falls into three main categories. The first category is Adaptive Optics which involves offloading tilt and focus and the passing of control of tilt and focus from Gemini Systems to NICI. The second category has to do with mechanism and environmental control and status information and the third category is array control and array data. The interface functions required for each of these categories is listed below:

Adaptive Optics Interface

Off load of focus
Off load of tilt
Enable/disable NICI or Gemini control of tilt and focus
Commanding membrane mirror stroke
Commanding of loop gain
Enabling or disabling NICI AO corrections
Querying APD counts

Mechanism/Environmental Control

Command positions of mechanisms
Query rotator position
Query telescope position
Enable/disable spider mask rotator servo
Enable/disable atmospheric refraction correction
Query temperatures
Query/set instrument state

Array Control

Command array operating parameters
Command a data taking operation
Send data to DHS

The following section will describe each of the interface issues listed above in greater detail.

3.0 Details of Interface Requirements

3.1 Adaptive Optics Interface

When NICI is running with AO corrections it will control the telescope fast focus and fast tilt. As such it must communicate with the telescope to take control of these functions from the telescope systems. The NICI AO system can only handle so much tilt or focus correction. When the limit is reached a command must be sent to the telescope to move the telescope of change the focus position of the secondary. These will be slow corrections that will happen periodically.

3.1.1 Off load of focus – As the telescope focus drifts the NICI AO system will correct for this wavefront curvature with the DM. When the focus correction in the AO system exceeds a preset limit a command will be issued from NICI to GEMINI to offset the focus by a certain amount in a certain direction. How often this happens will be determined by the focus drift rate of the telescope. Corrections should be expected at a rate comparable to what has been seen with the Hokupaa system. It is expected that these corrections will be made four times/hour.

3.1.2 Off load of tilt - As the telescope position drifts the NICI AO system will correct for this wavefront tilt with the DM and the tip/tilt stage behind the DM. When the tilt correction in the AO system exceeds a preset limit a command will be issued from NICI to GEMINI to offset the telescope by a certain amount in a certain direction. How often this happens will be determined by the tracking rate error of the telescope. Corrections should be expected at a rate comparable to what has been seen with the Hokupaa system. It is expected that these corrections will be made once per minute.

3.1.3 Enable/disable NICI or Gemini control of tilt and focus – In order for NICI to correct fast focus and tilt using it's on axis WFS it must take control from the telescope. When first slewing to a star the Gemini systems will be in control. Once the nominal focus is set and the star is positioned to about 2 arcseconds NICI will take control of the fast tilt and focus. A command will be required to both systems to allow this to happen. Also when the observation is complete Gemini must take back control and pause the AO system before slewing to a new object. It is expected that the tilt or focus will not jump when Gemini control is turned off. Tilt and focus may be enabled or disabled separately.

3.1.4 Commanding membrane mirror stroke – A free parameter for optimizing AO performance is the throw of the membrane mirror stroke, sometimes called optical gain.

This is typically commanded once at the start of a new object and is based on the seeing conditions and the brightness of the guide star. This is an input to the AO system and will be done typically at the start of an observation and not usually changed until a new object is selected.

3.1.5 Commanding of loop gain – The other free parameter for optimizing AO performance is to adjust the loop gain parameters. This is also based on seeing conditions and guide star brightness. This is an input to the AO system and will be done typically at the start of an observation and not usually changed until a new object is selected.

3.1.6 Enabling or disabling NICI AO corrections - An observing sequence will require setup during which AO will be paused or dormant. Once the object is acquired and adequate counts are witnessed from the APDs the AO corrections can be turned on. Under certain observing conditions, such as beam switching to the sky where there is no guide object the AO corrections will be paused and then continued when the telescope beam switches back to the object.

3.1.7 Querying APD counts – In order to set up the AO system and to verify that it is ready to start correcting the image the observer or observation controller must verify that sufficient counts as seen by the wavefront sensor detectors(APDs). Likewise the observer or Observation controller must ensure that the guide object is not too bright. This will involve querying the count rate from the APDs.

3.2 Mechanism/Environmental Control

The mechanisms are described in SDN#1001 - NICI Mechanism Top Level Functional and Performance Requirements.

3.2.1 Command positions of mechanisms - Each mechanism will have the following commands:

Initialize – find home position
Goto position X – move to the desired position
Query limit/detent status – in or out
Query encoder value
Query state – ready, moving, initializing, error

With the exception of the spider mask rotator and the steering mirror all of these mechanisms operate in a mode where the observer or observation control program will command a state for each mechanism and then wait for the mechanisms to complete transitioning to the new state before the observation continues.

The spider mask rotator and the steering mirror will both move during observations in medium speed servo loops(1 Hz update rates). Additional commands will be required for

these mechanisms to turn on and off the servos. Two pieces of information will be required for these two servos calculations:

Query rotator position – To tell the spider mask rotator what position to go to.
Query telescope position – To calculate the atmospheric refraction correction

Enable/disable spider mask rotator servo - This command will turn on or off the spider mask positioning servo. The servo program will read the rotator position and or telescope position at a rate consistent with the Instrument Rotator rate(sky position dependent) and move the spider mask to maintain alignment.

Enable/disable atmospheric refraction correction – This command will turn on or off the atmospheric refraction correction. When atmospheric refraction correction is enabled the algorithm will assume that the starting alignment at the IR focal plane is correct and the refraction correction will be calculated from that point on to maintain that infrared position. The steering mirror will then move to adjust for the differential movement between the visible image and the IR image.

Query temperatures – In order to verify nominal operation of the cryostat, arrays and electronics a temperature controller will be provided that will be read through the terminal server to provide temperature information.

Query/set instrument state – A command will be supplied that will return all NICI state information in ascii form to be used to populate the EPICS database and allow the setting of the instrument state.

3.3 Array Control

Details of the array controller requirements and commands can be found in SDN#1003 Array Controller Functional and Performance Requirements. These commands are summarized here in terms of setting the observation state, taking a data, aborting the present operation and what to do with the data.

Command array operating parameters – Almost all of the array controller commands are used to define the state of the coming observation. These include array operating parameters and voltages, readout modes and comments for the FITS header. The Go and Stop commands are the exceptions.

Command a data taking operation – This is the Go button. Once the observation state has been set data taking is initiated with the Go command. The operation then continues until completion according to the state parameters that were previously set.

Abort the present operation – Should an operation be started with an error in the observation parameters the Stop command will terminate the observation and return the controller to the ready and waiting state.

What to do with the data – There are three options for what to do with the data. Option one is to display the data on the engineering display but not save it and not send it to the DHS. Option two displays the data on the engineering display and saves the data to the local disk. Option three sends the data to the DHS for processing, quick look display, population of the FITS header and storage.