ICD for NAOMI to TCS

1. Summary

This is a preliminary ICD for the software interface between NAOMI and the WHT Telescope Control System. This interface is not yet properly defined, therefore this ICD summarises the NAOMI requirements in this area as well as stating what is currently known about the interface to the TCS.

2. TCS Interface to an Autoguider

It seems that the WHT interface to an autoguider is very similar to the INT interface. There is a document INT-PF-7 which describes the INT interface and also mentions the WHT interface as it was at that time (1995).

In brief, the document states

- The interface is an RS-232 connection
- The autoguider sends ASCII characters down this wire with a syntax containing three numbers - Xpos Ypos and time, readable with the FORTRAN FORMAT statement (2F4.1, F4.2) - that is, 12 characters followed by a carriage return.
- The Xpos and Ypos are the determined position of the guide star as measured from the readout corner of the autoguider CCD and measured in pixels.
- The time is in seconds and has various meanings depending on its sign -
  - positive - the expected delay to the next autoguider packet, allowing the TCS to detect a timeout
  - zero - end of autoguiding
  - negative - suspect data

What the document, therefore, implies is:-

- The TCS has a model of the autoguider. It assumes the autoguider is a simple CCD camera, and the autoguider software determines the position of the guide star within the CCD frame.
- The TCS must be informed independently of
  - The effective size of the CCD pixels (eg in tangent-plane arcsec?).
  - The orientation of the camera.
  - The demanded position in pixels of the guide star.

3. NAOMI and Autoguiding

NAOMI has X-Y control over the positioning of its pick-off which feeds a wavefront sensor containing an array of lenslets and two CCDs. There is a tip-tilt mirror which takes out small-scale rapid image motion as well as a deformable mirror.

When NAOMI is in use, it acts as the autoguider for the WHT. Small-scale autoguiding is achieved by the tip-tilt mirror (~5 arcsec of motion available). Larger scale autoguiding is achieved by sending bytes down the RS232 line to the DEC alpha.

Presumably, this description of the actual nature of NAOMI combined with the description of the interface precented by the TCS to an autoguider, implies that the NAOMI software has to invent a suitable virtual CCD camera to match the TCS requirements.

4. The Dithering Problem

Infrared arrays need flat-fielding several times a night. As a consequence observers need to be able to take flat-field data and observe astronomical sources at the same time. This is achieved by dithered observing, which consists of taking a set of short exposures of the science field with small offsets (18 arcsec is quoted) between them. Suitable processing can then extract both the flat-field and the science image.

I haven't had a clear statement about how short the exposures have to be, but there is concern about the dead-time in moving from one exposure position to the next. The trouble is that, once a guide star has been picked-up by the wavefront sensor, it takes a certain time for the adaptive optics system to get correctly adjusted. It is unknown what this time is, but people think it could occasionally be as long as 5 seconds. This is considered to be unacceptable, so a requirement was written that NAOMI has to maintain the adaptive optics lock on the guide star during the move from one dither position to the next.

The suggestion is that NAOMI keeps its lock on the guide star, but moves its wavefront sensor pickoff. This will cause it to send autoguiding positions down the RS232 line and cause the telescope to move.

Finer details have to be worked out, but presumably the tip-tilt mirror would be used so that the 18 arcsec motion would be fed to the telescope as about 5 smaller moves of size 3-4 arcsec. Smaller, as we must keep a significant fraction of the FSM dynamic range for real correction.

This leads to the following questions, and I have appended preliminary answers to these when available.

- Is an autoguider "error" signal of final total size equivalent to 18 arcsec acceptable to the WHT?
  - *Yes (answer from Marion Fisher).*

- How long would it take the WHT to respond to each of the 3-4 arcsec cumulative shifts?
  - *About 1 second (answer from Marion Fisher).*

- Is there some problem with this whole scheme which means that Frank Gribbin's preference for unlocking the adaptive optics system, performing a normal telescope move (possibly using the OFFSET command he mentions) and then locking the adaptive optics again has to be adopted?
  - *From the above preliminary answers, it is possible there would be no efficiency gain in retaining AO lock.*

5. NAOMI and Autofocus

The NAOMI system detects if the image is slightly out of focus and responds by adjusting the deformable mirror. As the defocus gets larger, NAOMI has to ask the TCS to adjust the telescope focus. This has to be done by sending a DRAMA message to the TCS. Clearly there has to be some way of relating the focus offset detected by NAOMI to the units meaningful to the TCS.