HJST coude autoguider advisory

Phillip MacQueen – 12 May 2020

Summary

A new autoguider system was installed March 2020 for use with TS1 and TS2, and replaces all functions of the previous autoguiding system. The previous autoguider system is uninstalled. This advisory is for users with an existing knowledge of autoguiding with the HJST coude instruments.

The new autoguider subsystems

The new autoguider system is composed of these subsystems

- a new guide camera, guide optics, and guider focus mechanism
- two new guider filter wheels
- a new flip mirror assembly
- a new slit viewer
- modified guider software

The significant changes (quick start notes)

- The size of the guider detector array is now 2560x2180 pixels instead of 512x512 pixels. The image scale is 0.1434 arcsec/pixel. The guider field of view covers 95% of the area of the 6 arcminute diameter instrument field of view
- The camera readout noise is approximately 1.4 electrons, and the gain is 0.48 electrons per DU. Full scale is 65,535 DU, and it would be wise to keep the signal level below 60,000 DU
- The limiting magnitude is ~V=21 in darktime, with the star off the slit, 1 arcsec seeing, the 400-700 nm filter, and a 30 s integration time
- The maximum integration time the camera head allows is 30 seconds (see the imaging section below)
- The guider camera does not have a shutter, and so can be left imaging continuously during the night without causing wear and tear on the camera
- The guider detector is not a CCD. It is a CMOS detector, and as such, cannot do on-chip noiseless binning. The guider software allows 'binning', but it is really 'summing' of pixels, and is not recommended because it reduces the dynamic range by a factor equal to the number of pixels summed
- The guider optics have much improved image quality, especially in the violet, blue, and near IR
- Previously the guider had the *Slit* and *Field* magnification modes due to the small CCD size, and now there is a single, fixed magnification. A user zooms in and out on the image in the guider software, using a low zoom magnification for field acquisition, and a higher zoom magnification to view the guiding
- The guider computer is called Zyla because the new camera is a Zyla 5.5 model from Andor. In the rare circumstance that Zyla needs rebooting, instructions are on the notice board in the coude slit room
- The guider assembly has a cap that protects the optics when the guider is not in use. The blue cap must be removed at the start of the night, and reinstalled at the end of the night
- Both guider filter wheels have been replaced. The first filter wheel has 7 neutral density filters. The second filter wheel holds 6 spectral bandpass filters, and a blocking filter
    - The spectral bandpass filters provide a compensation mechanism for atmospheric dispersion when observing away from the zenith. Throughput can be maximized in a spectral region of interest by guiding through a filter centered on that region.

    - The neutral density filters allow the peak flux from the guide star to be kept under 60,000 DU for all stars in the sky with the normal guiding integration time of 5 seconds. Some filter ghosts are visible when using the neutral density filters
- The guider can be focused from the *Instrument Control* window of the guider software. The software also changes the guider focus automatically when the filters are changed. For some filter changes it can take up to 10 seconds for the focus change to complete
- With filter wheel 1 in the *Open* position, and filter wheel 2 at the *495-565nm* filter, the guider focus value is *-5000*. The guider focus is stable with time or temperature, and should not need adjusting
- The telescope focuses the star on the slit. The guider focusses the slit onto the guider CCD. *Do not* use the calibration system as a source of light to check the guider focus. Instead, point the telescope at the dome away from the dome lights, and use the light through the telescope for guider focus checks.
- The guiding fiducial (the guiding crosshair) is moved automatically when the filters are changed so that the fiducial stays in a fixed position relative to the image of the slit. Typical moves are 0.5-2.5 pixels
- The guide camera has been seen to *freeze up* at times. It usually corrects itself within approximately 40 seconds. Freeze ups seem related to using the guider software to move the telescope while *autoguiding* is turned on. The guider software now prevents moves while autoguiding is on
- The flip mirror that selects between the autoguider and slit viewer, for each of TS1 and TS2, has been replaced. The new 4-position flip mirror is significantly more stable and repeatable
- The flip mirror now has a cover. The blue cover must be opened at the start of the night, and closed at the end of the night
- The slit viewer (sometimes misnamed *the eyepiece*) has been replaced. The new slit viewer has greatly improved image quality, and a single magnification. The full 6 arcminfield can be seen for acquisition, while the slit is simultaneously highly resolved with approximately 0.1 arcsecond resolution
- Focusing the telescope using the slit viewer is easier if there is a little illumination of the slit from a light such as a flashlight. This enables the background including the slit to be seen as well as the star. Eventually there will be a switch actuated illuminator for this function
- The slit viewer has a blue cover cap that needs to be removed before use, and reinstalled after use. The eyepiece has a black cap that must also be removed for use, and then reinstalled

Imaging with the autoguider (quick start notes)

- The *Name* data entry box in the *Exposure Setup* window is used to specify the directory and filename root. An example is */data1/atlas/pjm/20200512/CometAtlas*. A four digit number is appended to the root, eg. *CometAtlas0001*, and increments from frame to frame.
- An object name can be included in the FITS file header in parameter OBJECT. Enter the object name in the *Object* data entry box in the *Exposure Setup* window
- The coude image *rotates* on the guider detector as a function of HA and Declination. The position angles of north and east are written in the FITS file headers
- The *blocking* filter and a *6.25-magnitude* neutral density filter should be used together if bias or dark frames are taken. This is because the camera does not have a shutter
- Slit plug 18 does not have a slit in it. Note that slit plug 18 has lower reflectivity than some other plugs and might not be the best choice when throughput is critical
- Integration times longer than 30 seconds are achieved by combining images. The guider software can sum images via the *Exposure Setup* window, but higher quality combining can be done by the user in data reduction. The sky noise is likely to be higher than the camera readout noise and so this is largely a noiseless process