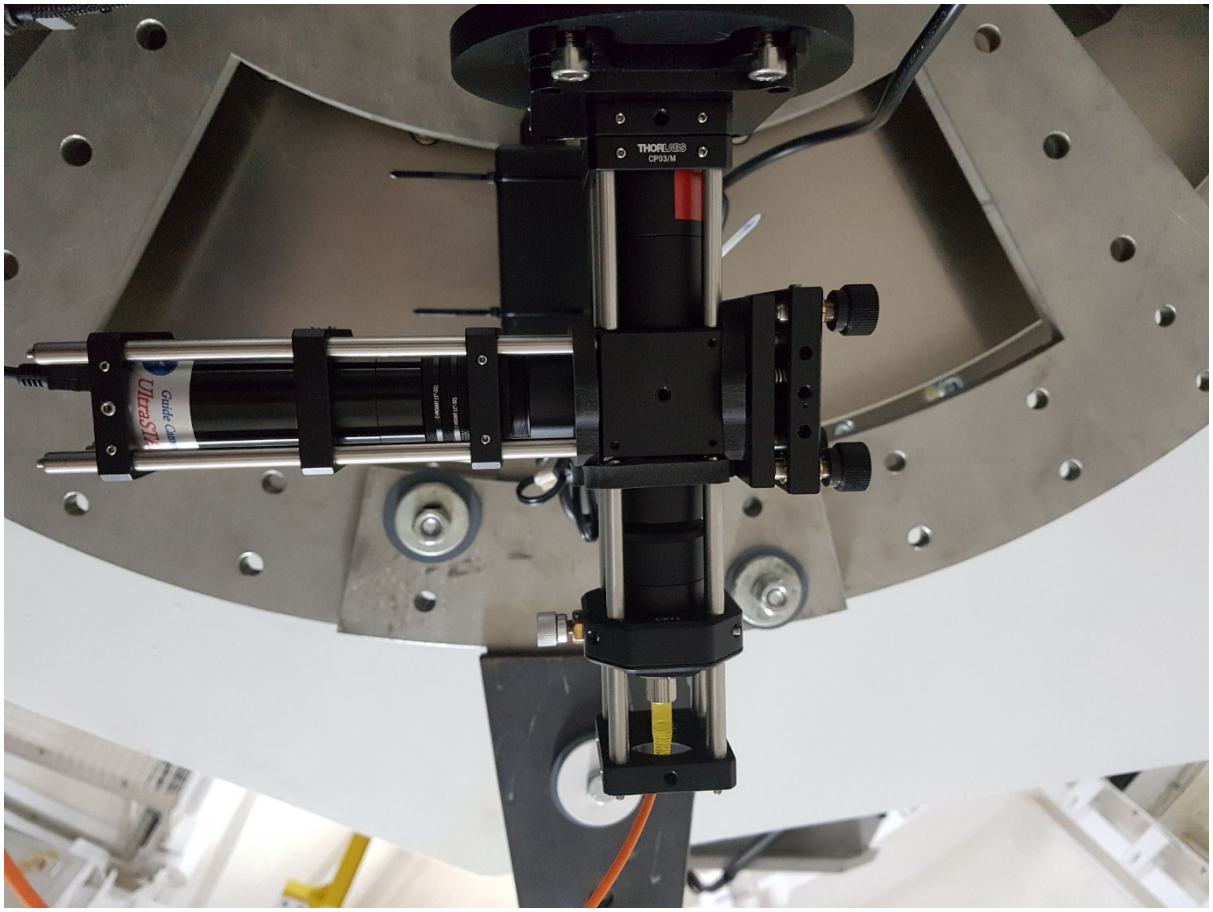
Acquisition and Guiding Unit (AGU Mk 1)

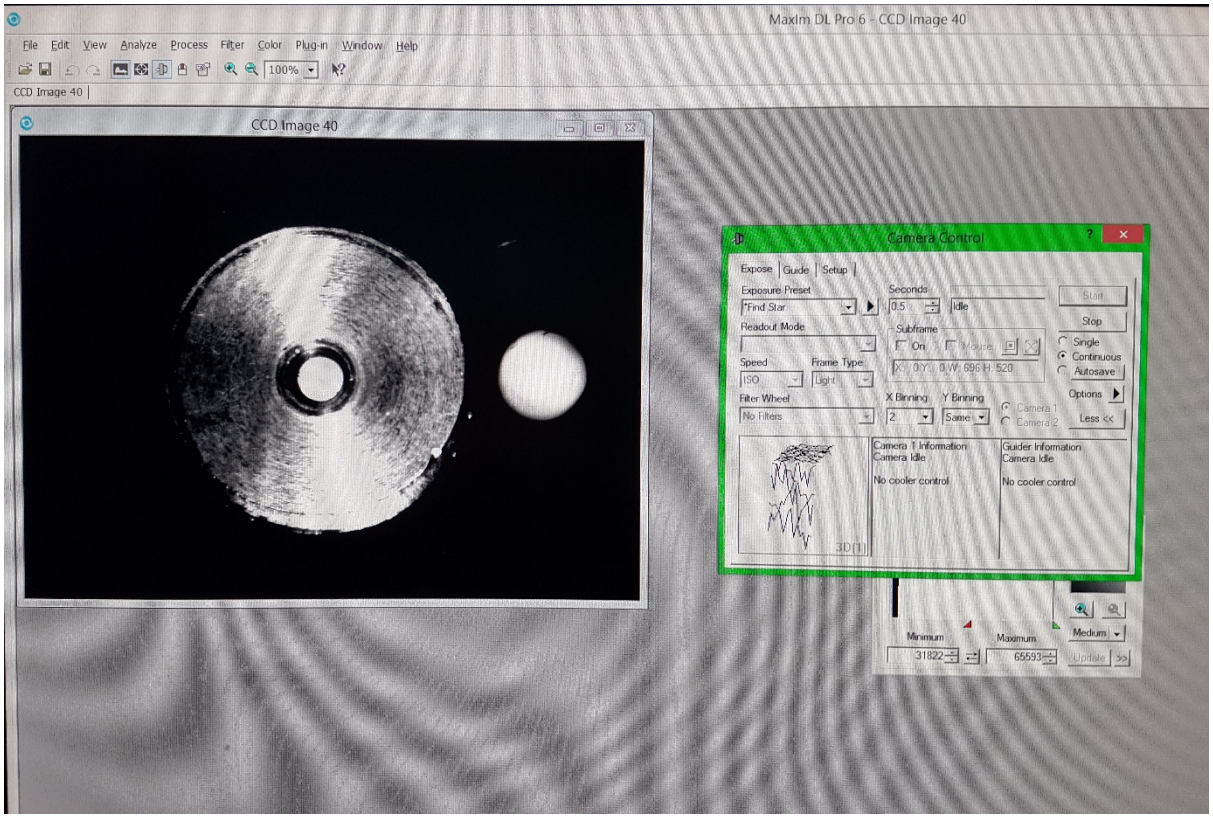
Unit Description

The Acquisition and Guiding Unit (AGU) was designed to couple a star image at the focal plane of the Thai National Telescope (TNT) to an optical fibre. It is a simple optical design constructed from off-the-shelf components that allows simultaneous direct imaging of the target star and the focused image of the star at the fibre face. The internal camera is a high quality guiding unit that can also allow closed loop guiding of the telescope.

Inputs and Outputs, Guiding

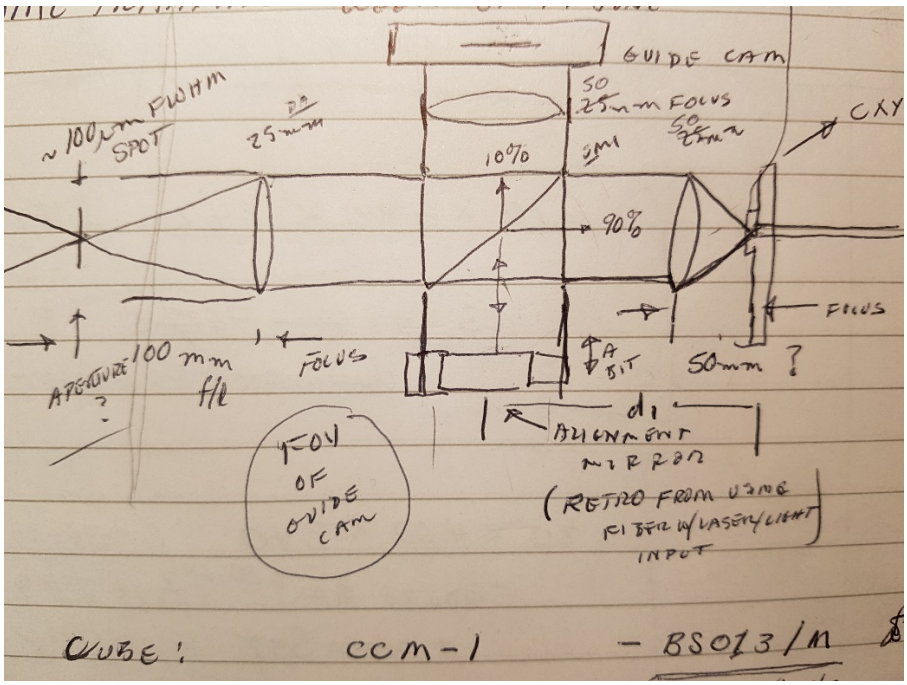
The required optical input to the unit is from the Nasmyth focal plane of the telescope. The input lens of the unit must be positioned at 100mm, the input lens focal length, from the focal plane. The optical output of the unit is a 50um core graded index FC/PC connectorised fiber that is connected directly to the unit. The camera requires a powered USB 2 mini connector to a networked pc for operation with an UltraStar camera driver from Starlight Xpress. Fig 1 shows the AGU installed on the TNT. Fig 2 shows a camera output with a defocused star image on the…..





Design

Fig 3 shows the original sketch of the design. The optics consist of three lenses, a beam splitting cube, and a mirror. The optomechanical parts include simple threaded focusing mounts for the lenses, a two axis mirror mount, and a fiber connector mounted in an x-y translation stage. A 30mm rod system supplies the mechanical frame in which all the components are mounted.



The input lens collimates the star image at the telescope focal plane. Most (90%) of this collimated beam passes through the beam splitter cube and is focused on the face of the optical fiber. A fraction (10%) of the light is directed to the camera focusing lens. The camera thus images the target star. The back reflected light from the face of the fiber is reflected from the beam splitter to the mirror and this light also comes to a focus at the camera. There are multiple weaker reflections due to the many optical surfaces but it is easy to distinguish the bright star and the reflection from the fiber face. The position of the latter image in the camera can be changed with the mirror adjustments.

The initial design specs for the lenses are 100mm focal length for the input collimating lens and 50mm focal length camera and fiber focusing lenses. All are AR coated cemented achromats. With these lenses the performance on TNT is as follows:

Camera FOV (1393x1040 pixels): 157x118 arcsec, 2.6x2.0 arcmin (0.113 arcsec/pixel)

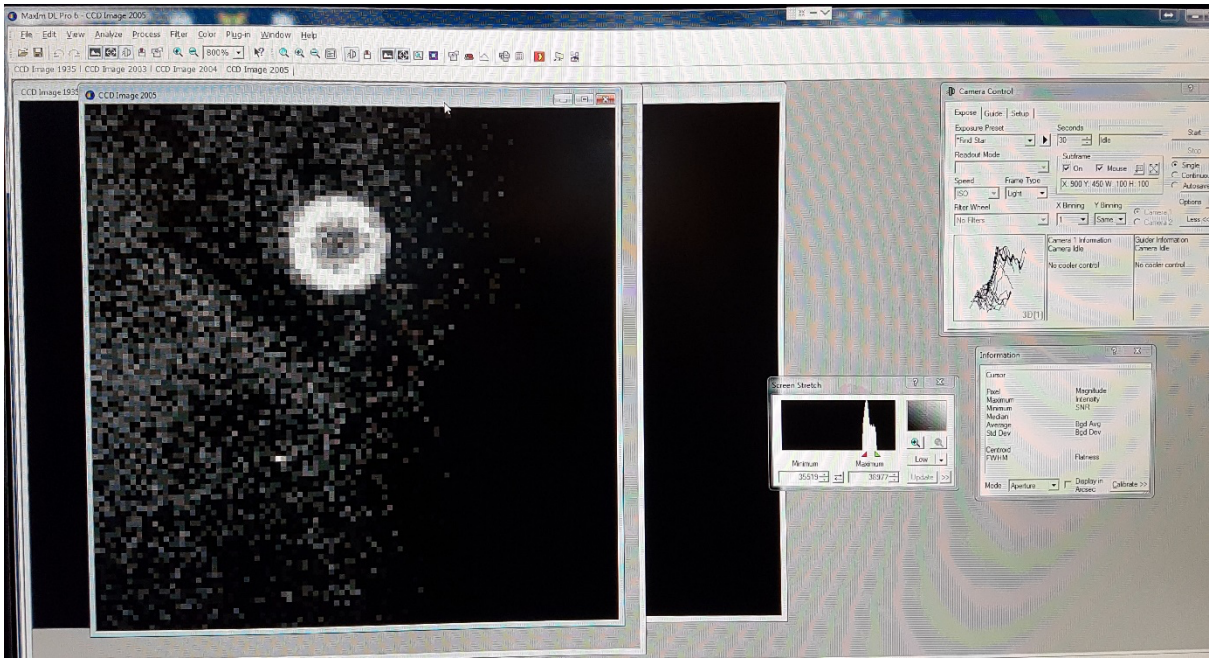
Fiber core: 1.2 arcsec diameter (1:1 imaging, 6.45um pixels), ~9x9 pixels

Setup and operation

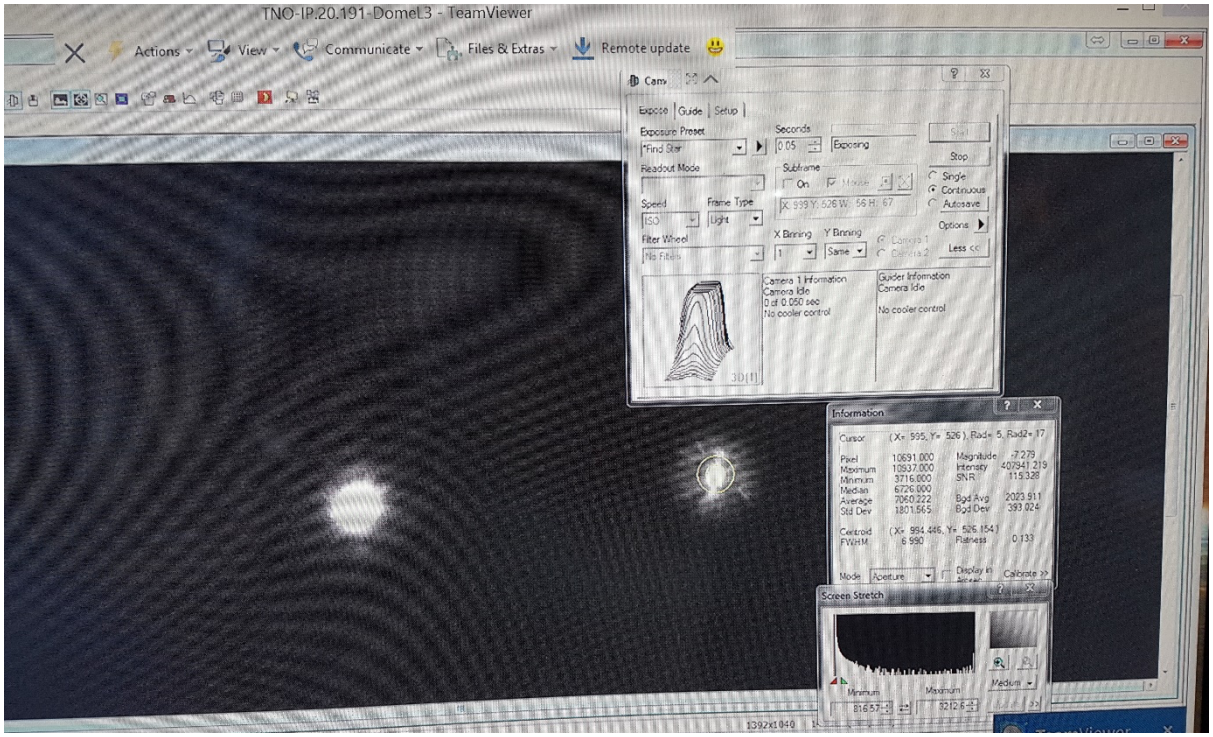
Initial assembly and setup of the unit is critically dependent on one component, the camera. The camera lens must be precisely focused at 'infinity', a very distant object or star using the only camera and its lens with no other components. This then sets the focal positions for the telescope and fiber collimating lenses. After assembly the position of a test input object (the location of the focal plane of the input lens) is found by moving the object until it is in focus on the camera. The lateral position of the image is not adjustable in the camera but rather with the object itself. For the optical fiber focus, an optical fiber is connected to the output FC/PC connector and light is sent 'backwards' into the unit. The focus at the camera is adjusted with the fiber coupler lens. If the test input object is also an optical fibre output then adjusting the x-y position of the output connector can be done easily.

Calibration, coarse focus

Before assembly focus the camera lens to infinity. The centred fibre optic with room light or a laser input can be used to find the focal position of the object plane and the centre. This is fixed in the camera image. Record this location. Using another fibre at the output connector adjust the x-y position of the connector until maximum light is detected. Do the same with the fibre output collimation lens. With lots of room light you will also see the connector is in focus. The output fibre is now centred and roughly in focus. Place this image next to the object plane centre using the mirror adjustments. Record this position. With only a fibre connected to the output you should see faint light where the fibre optic face is if the room lights are on at the telescope. If focused you will see the 'donut' in Figure 4.



This ‘donut’ is the image of the output fibre. The darker area is the core of the fibre which is the location to place the image of the star. The fibre image can be placed anywhere in the camera field of view by using the two adjustments on the mirror. In operation you will see a camera image that looks like Figure 5. The spot on the left is the image of the star and the spot on the right is the reflection from the face of the output optical fibre.



Operation

Point telescope to the target star. See one bright spot (maybe two). Centre the brightest spot on the object centre you recorded previously. Focus this image using the telescope focus. See two bright spots. Fine position and fine focus using the telescope focus and pointing to give the

smallest image on the fibre location. Keep it there. Check for maximum light at the spectrograph. Take data. Manually guide* the telescope to keep the focused star image on the fibre

*Autoguiding to be installed after Feb 2020

Optical Layout and component functions

Parts list

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