MRO FTT/NAS & FLC

FLC Assembly Procedure

MRO-PRO-CAM-1200-0180

The Cambridge FTT Team

rev 1.1

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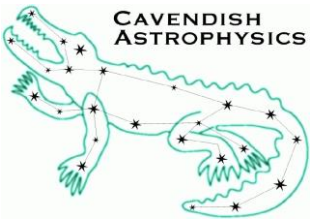

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Change Record

Revision	Date	Author(s)	Changes
0.1	2015-09-22	MF	Initial draft content
0.2	2016-03-24	MF	Complete draft of assembly procedure
1.0	2016-04-19	MF	First release (including focusing section)
1.1	2016-04-20	JSY	Minor corrections

Objective

The purpose of this document is to describe the assembly and positioning of the First Light Camera (FLC) version of the Fast Tip Tilt (FTT) camera system to be placed on the UT Nasmyth table.

Scope

The document describes the FLC components (as shipped) and provides the procedure for assembling the optics and mounts. The preferred layout of the components on the UT Nasmyth table is presented and the means of adjusting the position and focus of the camera is described. This document is only applicable to the FLC and does not relate in any way to the FTT camera (except that the same physical EMCCD camera is used as the detector.

Reference Documents

RD1 Technical Requirements: Fast Tip-Tilt/Narrow-field Acquisition System (INT-403-ENG-0003) – rev 2.2, May 20th 2010

RD2 First Light Camera Description (MRO-TRE-CAM-1200-0181)

Applicable Documents

AD1 First Light Camera Drawing Set

AD2 First Light Camera STEP file

Acronyms and Abbreviations

FTT Fast Tip-Tilt

FLC First Light Camera

MROI Magdalena Ridge Observatory Interferometer

NAS Narrow-field Acquisition System

NMT New Mexico Tech

TBC To be confirmed

TBD To be determined

UT Unit Telescope

Table of Contents

1 FLC Components

This set of components provides what is needed (except for the camera itself) to assemble the First Light Camera (FLC) on the Nasmyth optical bench to test the telescope. A description of the FLC is given in RD2.

1.1 FLC Optics and Mounts

The FLC optics and mounts are the set of components that divert the light from the telescope to the FLC camera. The parts, shown in Figure 1, are disassembled and boxed for shipping and consist of the following:

i. A custom focus lens (in suitable protective packaging, e.g. the plastic box referred to later).
ii. A flat mirror (in suitable protective packaging, e.g. the plastic box referred to later).
iii. A custom lens mount and base-plate, support legs, fixing screws and table clamps.
iv. A custom mirror mount and base-plate, support legs, fixing screws and table clamps.
v. A custom camera support bracket with fixing screws, clamps and push blocks (not shown).
vi. Miscellaneous fixing screws (not shown in these photographs) are included in the packaging.

Figure 1: FLC optics and mounts. The two mounts are on the right hand side of this picture and one (to the right) has the optic fitted while the other optic is in the paper wrapping on the left hand side. The base-plates and support legs are in the lower left of the picture together with clamps that will secure the base-plates to an optical table at the telescope. The 2 push blocks, used for adjusting the position of the camera to focus it, are not shown.

A drawing set for these components exists (AD1) in pdf format. Also a STEP of the assembled system on the UT Nasmyth table is provided (AD2) and shows the layout suggested later in Figure 6.

1.2 Optics packaging

The optics, a flat mirror and lens, are packed separately in protective paper in a plastic case or a box. An example is shown Figure 2.

Figure 2: Optics packaging. The lens or mirror is packed in protective paper within a plastic box.

1.3 Lens Mount

The lens mount will hold the focusing lens which directs light to the mirror. It is an aluminium bracket, shown in Figure 3, with a circular aperture to hold the lens and four holes in the base which are used to attach it to its base-plate.

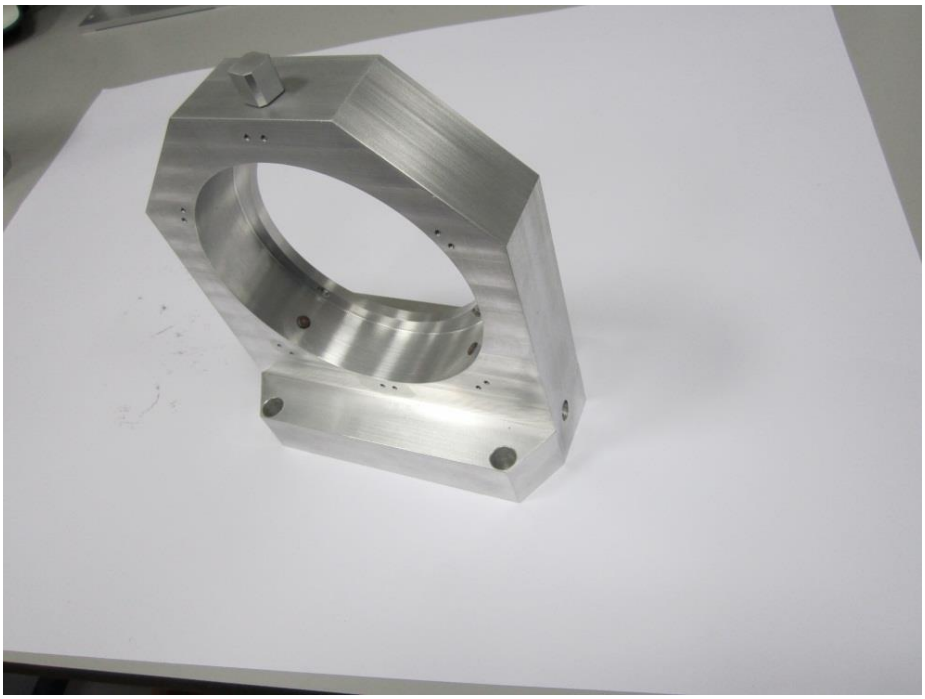

Figure 3: The lens mount

1.4 Mirror Mount

A mirror mount holds the flat mirror that directs the light onto the EMCCD camera (not shipped) and which attaches to the camera mounting plate. The mirror mount is an aluminium bracket, shown in Figure 4, with a circular aperture to hold the optic and four holes in the base that are used to attach it to its base-plate.

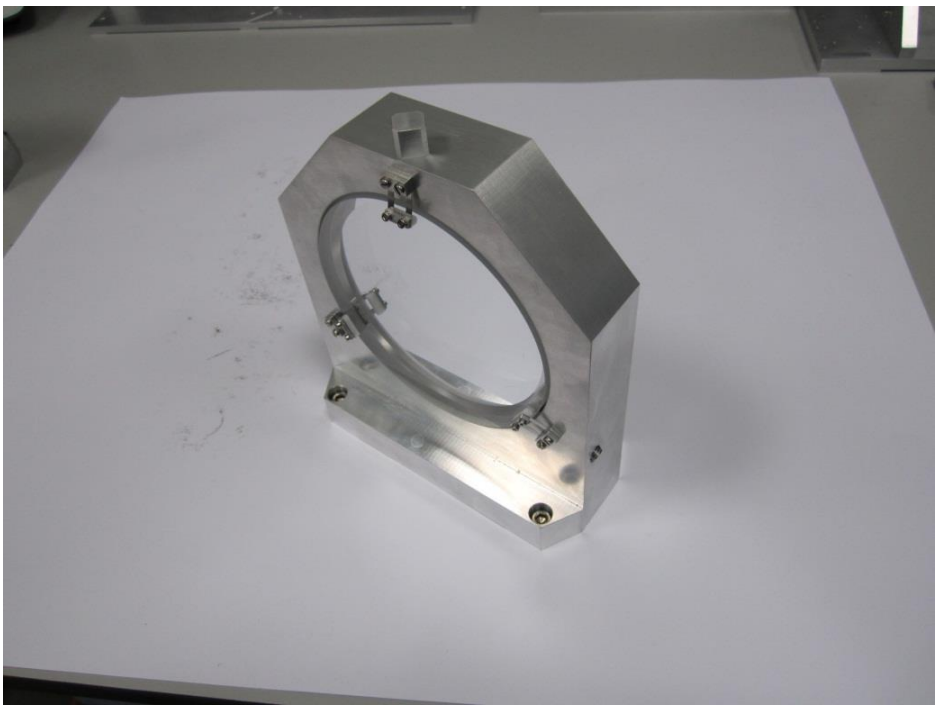

Figure 4: The mirror mount with an optic installed.

1.5 Camera Mount

The camera mount is a simple bracket made of two plates screwed together as depicted in Figure 5.

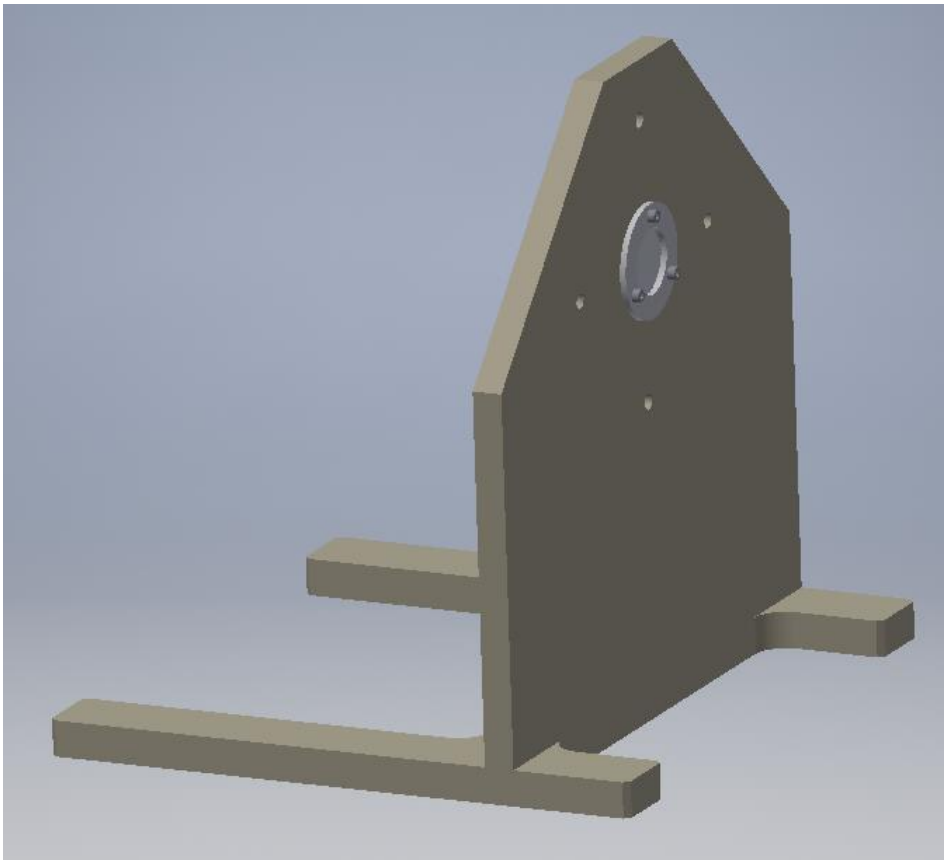

Figure 5: The assembled camera-mounting bracket including the filter retainer.

2 FLC Assembly

2.1 General Layout

The layout of the FLC camera on the Nasmyth optical table can be adjusted to suit the user's requirements, depending on whether other items are also present on the table. However the size of the optical table and the focal length of the lens dictate that a fold mirror must be used. This fold mirror must be placed between the lens and the camera as shown in Figure 6. The relative positions of these components can be changed at will and the mirror does not need to produce a right angle deflection of the beam but it is simpler to lay out the components this way. i.e. aligned with holes on the table to aid in its installation.

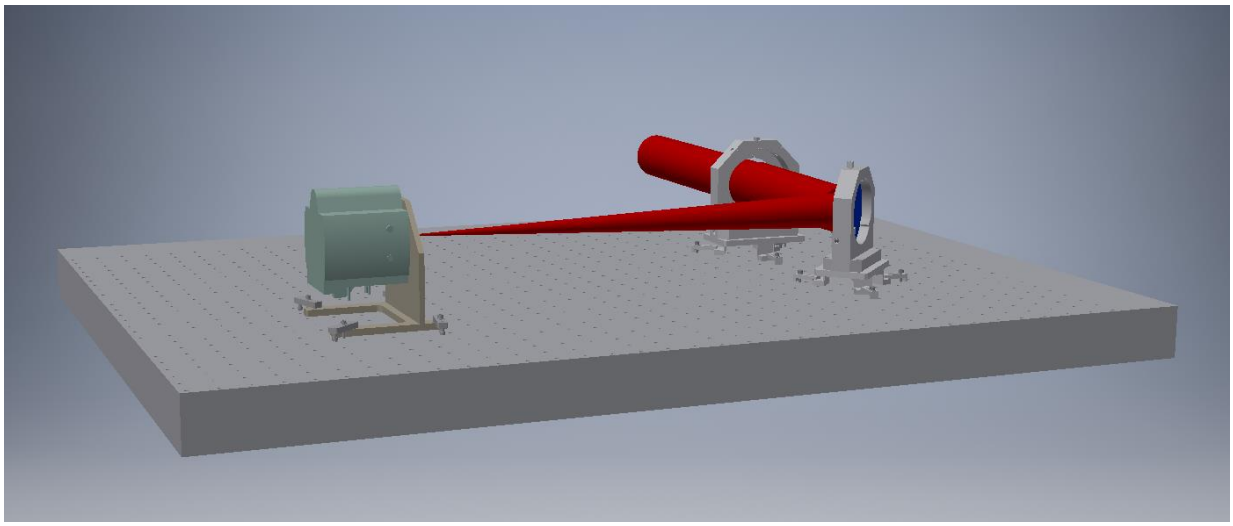

Figure 6: General layout of the FLC camera system on the Nasmyth optical table. The beam from the telescope (shown in red) enters near the top of the picture, passes through the lens and is directed onto the camera by the fold mirror. The lens and the mirror are centred on the nominal axis of the telescope output beam. Their separation is not important as long as the focus of the lens allows the camera to be fitted to the table.

2.2 Lens Assembly

The FLC lens mount is shown in Figure 7 with the lens and the baseplate fitted. This shows the balls located in the base of the recess. against which the lens is held by spring-loaded tabs fitted to the front face of the mount. The lens is supported axially by two adjustable pads and retained against them by a spring-loaded nut on top of the mount. The lens mount is screwed to the aluminium plate and the three mounting legs fitted. The assembly is then ready to be positioned and clamped to the Nasmyth table.

2.2.1 Assembly procedure

1. The lens mount should already be fitted with the axial supports and spring loaded retaining nut.
2. Remove the retaining nut and lay the mount down so that the lens recess faces upwards.
3. Unpack the lens using optic handling gloves, identify the flattest face and lower the lens into the recess in the mount so that the flattest face is upwards and the lens is resting on the three balls.
4. Ensure the lens is located against the two axial supports and re-fit the spring pre-load nut.
5. Assemble and fit the three retaining clips (see Figure 8).
    a. Fix the acetal pad to the leaf spring using a clamp plate and fixing screws.
    b. Fix the leaf spring to the mount using the spacer and clamp plate with fixing screws.
    c. Note that only three of the six locations for the springs are used, as shown in Figure 7.
6. Fit the three support legs to the base-plate using two fixing screws per leg.
7. Turn the mount upright and fix to the aluminium base-plate using four cap-head bolts.
8. If the lens does not appear centred in the mount adjust the two axial screws appropriately.

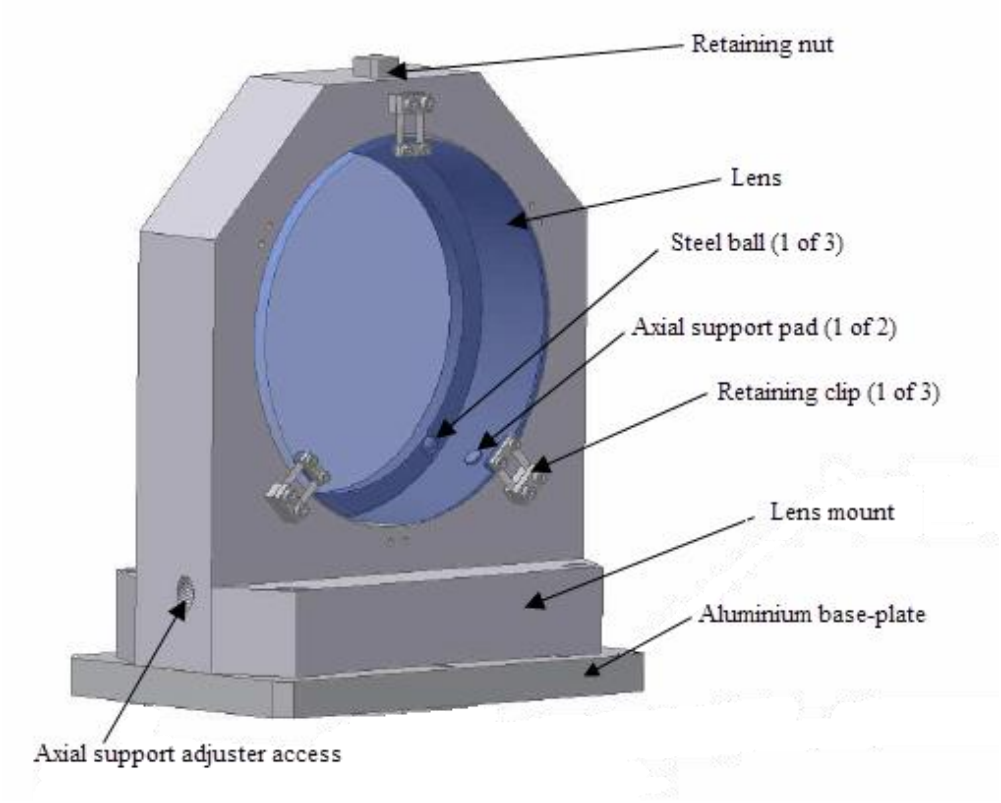

Figure 7: FLC lens mount with lens and aluminium base-plate fitted. The lens is retained against three steel balls (set into the base of the recess) by three spring loaded retaining clips fitted to the face of the mount. The lens is supported axially by two adjustable pads and retained against them by a spring loaded nut on top of the mount. The aluminium plate is an interface between the lens mount and the three mounting legs which screw into it. The mounting legs are clamped to the Nasmyth table when the lens has been positioned but allow some flexibility to account for thermal expansion between the assembly and the steel optical table.

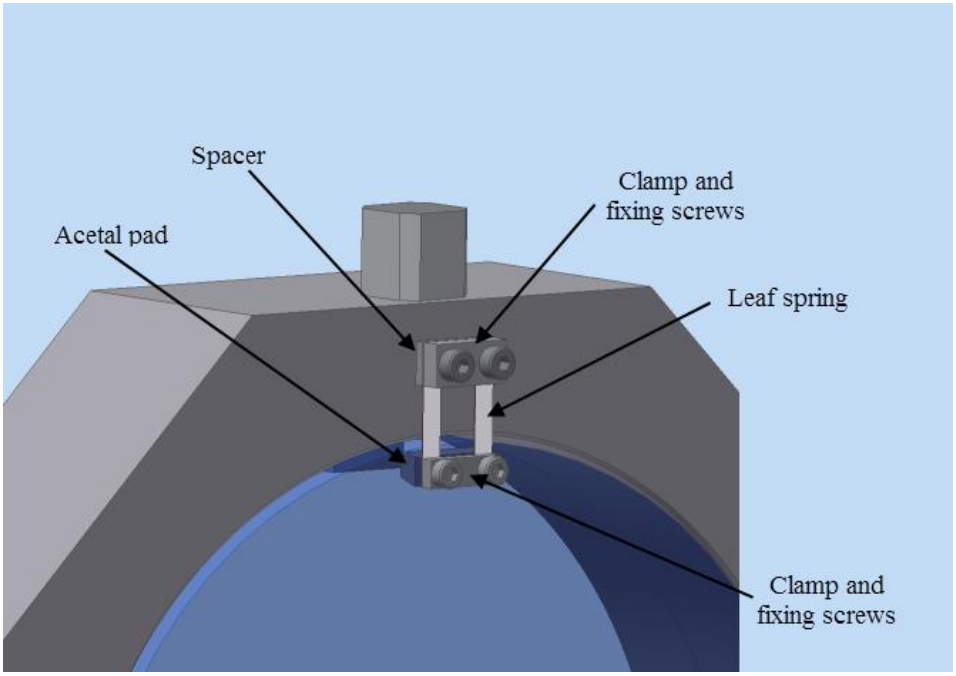

Figure 8: Detail of the retaining clip for the lens and mirror. The acetal pad is clamped to the leaf spring using the clamp plate and fixing screws. The retaining clip is then fixed to the mount using a spacer and another clamp plate with fixing screws.

2.3 Mirror Assembly

The mirror mount (shown in Figure 9) is assembled in the same fashion as the lens mount.

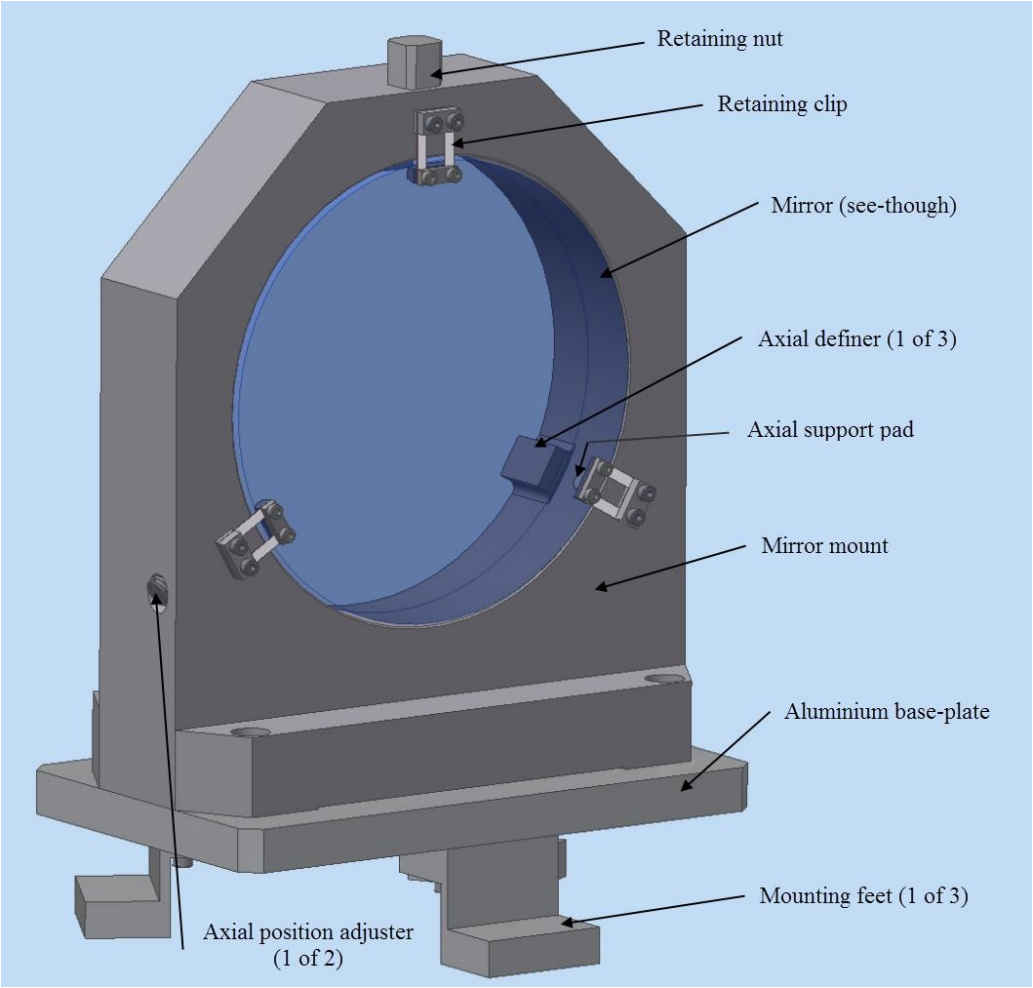

Figure 9: FLC Mirror mount. The mirror is shown as a see-through part for clarity, and is retained against three axial defining tabs by three spring-loaded retaining clips fitted to the face of the mount. The mirror is supported axially by two adjustable pads and retained against them by a spring loaded nut on top of the mount. The aluminium plate is an interface between the mirror mount and the three mounting legs which screw into it. The mounting legs are clamped to the Nasmyth table when the mirror has been positioned but allow some flexibility to account for thermal expansion between the assembly and the steel optical table.

2.3.1 Assembly procedure

1. The mirror mount should already be fitted with the axial supports and spring loaded retaining nut.
2. Remove the spring-loaded retaining nut and lay the mount down so that the axial definer tabs are lowest and the mirror can be loaded from the top.
3. Unpack the mirror using optic handling gloves and, with aluminised face upwards, lower it into the mount until it is resting on the three axial defining tabs.
4. Ensure the mirror is located against the two axial supports and re-fit the spring pre-load nut.
5. Assemble and fit the three retaining clips (see Figure 8).
    a. Fix the acetal pad to the leaf spring using a clamp plate and fixing screws.
    b. Fix the leaf spring to the mount using the spacer and clamp plate with fixing screws.
6. Fit the three support legs to the base-plate using two fixing screws per leg.
7. Turn the mount upright and fix to the aluminium base-plate using four cap-head bolts.
8. If the mirror does not appear centred in the mount adjust the two axial screws appropriately.

2.4 Camera Assembly

The base-plate is an H-configuration with countersunk holes allowing it to be screwed to the vertical plate to which the camera attaches. The vertical plate has four holes for attaching the camera and a recessed hole into which a glass filter is mounted. The filter is retained by a ring and three screws. It does not matter which way round the filter is fitted. The assembly is stable with the camera fitted but the camera cable may topple the assembly if it is caught. To prevent this and any movement of the camera once aligned the camera assembly is clamped to the optical table with the clamp brackets and screws supplied.

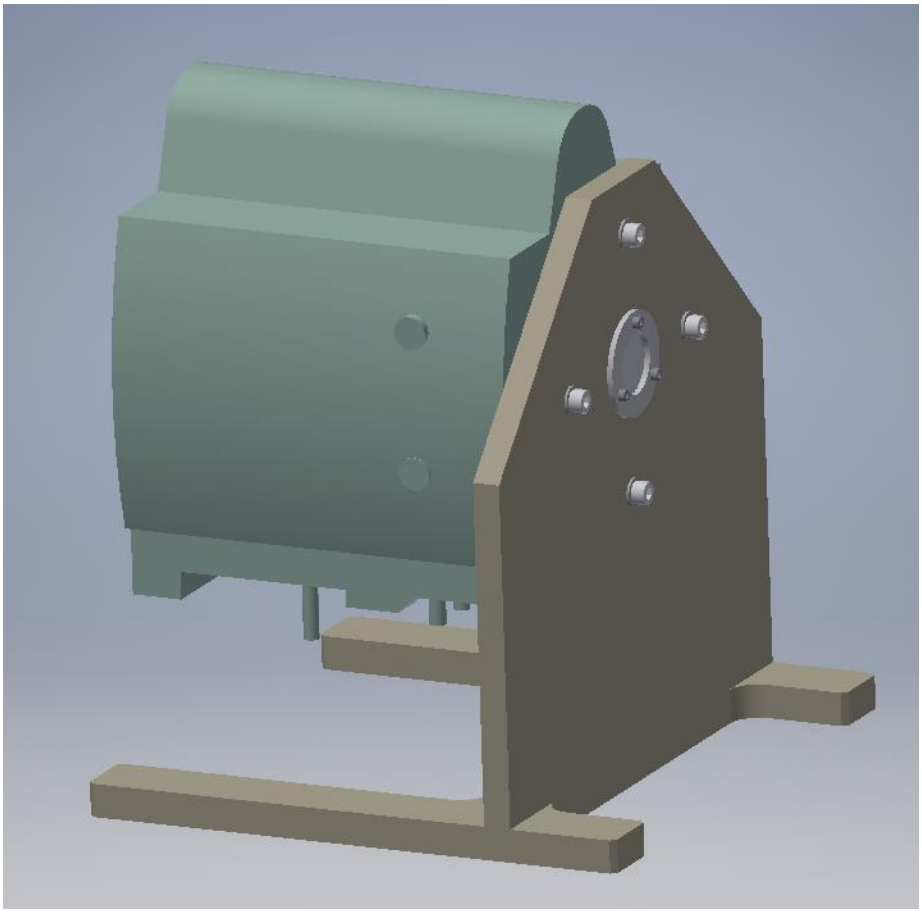

Figure 10: The cartoon shows the simple camera mount (with Andor EMCCD camera fitted) which is used when a thermal enclosure is not necessary. The base-plate and upright plate of the mount are first screwed together and the filter is inserted into the face-plate, held there by the clamp ring. The camera is then fitted using four mounting screws. When used without a thermal enclosure it is not necessary to fit cooling pipes and so the only connections to the camera required are the camera data/control cable and the Peltier power supply cable (both not shown here).

2.4.1 Assembly procedure

1. Remove the filter retaining ring from the face-plate and insert the red filter into the recess.
2. Refit the retaining ring.
3. Assemble the face-plate to the base-plate using the cap-head screws such that the filter retaining ring faces the short stubs of the base-plate.
4. Remove any packaging/protection from the Andor camera so the flat mounting surface is revealed.
5. Fix the Andor camera to the rear of the face-plate using the longer cap-head bolts provided.
6. Attach the camera data/control cable and Peltier cooler supply cable to the connectors on the underneath of the camera only after the camera is restrained on the table using the base-plate clamps provided.

2.5 Setting out the FLC components

There is considerable latitude in how the FLC components are laid out on the optical table but for whatever arrangement the components are set by dead-reckoning using the hole pattern. The recommended positioning constraints for a layout such as depicted in Figure 11 are as follows:

a. The axis of the exit beam from the telescope should be pre-determined and marked on the table if possible; this is the nominal axis.

b. The lens must be positioned along the nominal axis such that the fold mirror can be placed 'after' it, in order to direct the beam to the camera. It is helpful, but not required, if the fold mirror diverts the beam by 90°.

c. The lens should be centred on the nominal axis to within ±1 mm and the base of its mount set square to the edge of the optical table using a standard engineer's square.

d. The lens should be installed so that its more curved surface is facing the collimated beam arriving from the telescope.

e. The mirror centre should also be on the nominal axis to within ± 2 mm.

f. The camera should be placed on the diverted nominal axis produced by the mirror and then set square with the hole pattern on the optical table.

g. The combined distance L1 plus L2 should equal the approximate focal length of the lens, i.e. 1250 mm.

h. To make suitable adjustments to the camera position, particularly in focus, the camera base can be constrained by screw blocks while its position along the nominal axis is adjusted also using screw blocks. It is recommended that two screw blocks are used to engage the camera mount on one side whilst another is used on the other side as shown in Figure 11. This will constrain the camera from shearing or rotating on the table as focus is adjusted. For focussing just one screw block can be used at the front of the camera mount to push the camera rearwards. To move the camera forward the screw block should be wound back and the camera mount pushed forward to engage it.

i. With the camera in the optimum position the base should be clamped and then the screw blocks unwound slightly to prevent an over-constraint.

j. The clamps should not be very tight because of the different CTE between the aluminium base and the steel of the table. Enough clamping force should be used to prevent the camera from easily being moved.

k. To readjust focus or shear of the camera, should either be necessary, the screw blocks should be re-engaged with the mount base before the clamps are removed or slackened. The motion required should then be applied using the screw blocks, clamping down again and backing off the screw blocks once alignment is complete.

l. The camera position may need further slight adjustment to obtain both the optimum field of view and focus. This could be done by observing e.g. a known field of stars or a globular cluster. Alternatively if a laser is set up to project along the telescope axis where it exits the telescope, the initial alignment could be done using that.

m. A Bahtinov mask can be used to aid focussing the camera. The mask can be temporarily attached to the face of the lens mount nearest the telescope using double sided tape or similar substance. The mask need only be approximately centred.

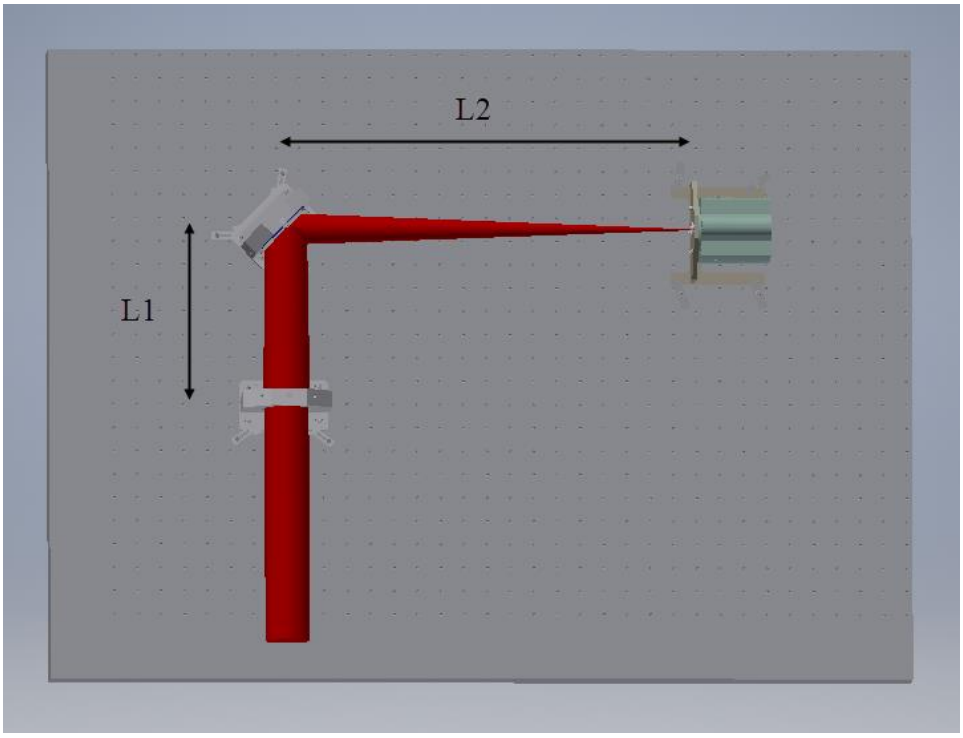

Figure 11: A general layout of the FLC components. Alignment of the components will be easier if they are referenced to the hole pattern on the optical table and the fold mirror is set at 45° to the arriving beam. The distance between the lens and the mirror is arbitrary as is the position of the lens along the exit beam of the telescope. The camera does however need to be positioned at the focus of the lens.

2.6 Focusing the FLC camera

Focusing the FLC can be done by placing a Bahtinov mask (see, e.g. www.spike-a.com) in front of the lens, and imaging a bright star using M3 alone, i.e. with the telescope operated in "tube offset" mode. The FLC will be in focus when the diffraction spikes seen in a medium-exposure image are "centred" and form a symmetric pattern in the image (see below).

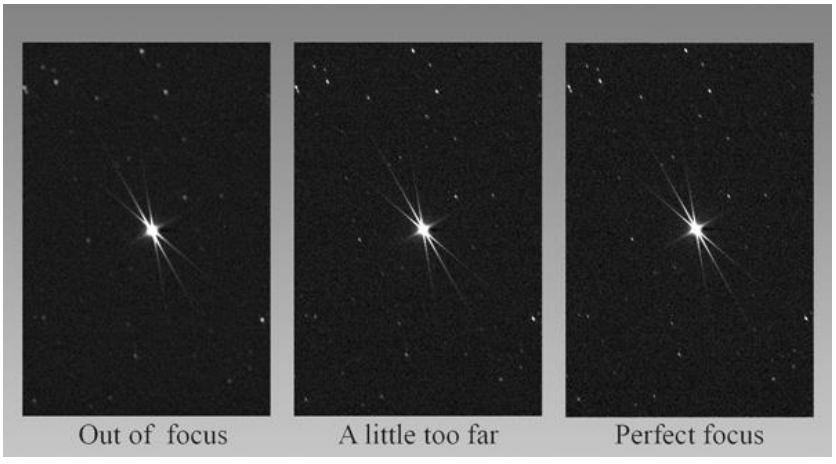

Figure 12: Images obtained with a telescope and Bahtinov mask, with varying degrees of de-focus. The mask produces stellar images that have a diffraction pattern comprising a cross, made up of two intersecting lines, together with a third line that moves across the centre of the cross as the telescope is adjusted in and out of focus. Correct focus is achieved when the centre line fits exactly in the centre of the cross (right hand image).