8.6 On-Instrument Wavefront Sensor (OIWFS)

8.6.1 Introduction

The GNIRS OIWFS is a hybrid, consisting of mechanisms that are copies of those manufactured for the NIRI OIWFS and supplied to the GNIRS project by Gemini; these mechanisms are installed in a GNIRS-fabricated bench mounted to the main optical bench of the instrument. The optical layout of the GNIRS OIWFS is equivalent to that of NIRI, but the physical arrangement is simpler, without the two flat fold mirrors used in the NIRI configuration.

Because the OIWFS was delivered to the GNIRS project, this document will not be a comprehensive maintenance manual, but will cover aspects specific to its use in GNIRS. For completeness, some general subjects, such as detector installation and alignment, will be covered, based on documentation provided to NOAO by the Institute for Astronomy (IfA) in ICD 1.9b/1.10.

Detailed drawings for the IfA-supplied OIWFS components can also be found in the above-referenced ICD. These were not replicated in the NOAO GNIRS drawings series 89-NOAO-4200, so one must refer to the ICD for component details.

8.6.1.1. General Description

A schematic layout of the OIWFS is shown below in Figure 8.6.1. The major subsystems are:

- Field Lens Assembly
- "Combo" Lens Assembly (Collimator and Camera)
- Gimbal Mirror
- Filter Wheel
- Shack-Hartmann Optics and Detector Focus Assembly

8.6.1.2. Preparatory Steps

Any work on the OIWFS, with the exception of the Field Lens, will require significant disassembly of the instrument. The front section of the field lens tube can be removed after removal of the front shell and front active shields (8.4.3 – 8.4.51`1`). Work on the other subassemblies will require removal of the cold bench from the bulkhead and the active shields from the bench (8.5.1). The Filter Wheel and Detector Assembly can be accessed with the OIWFS bench installed on the main optical bench. The OIWFS bench must be removed to access either the "Combo" Lens Assembly or the Gimbal Mirror.

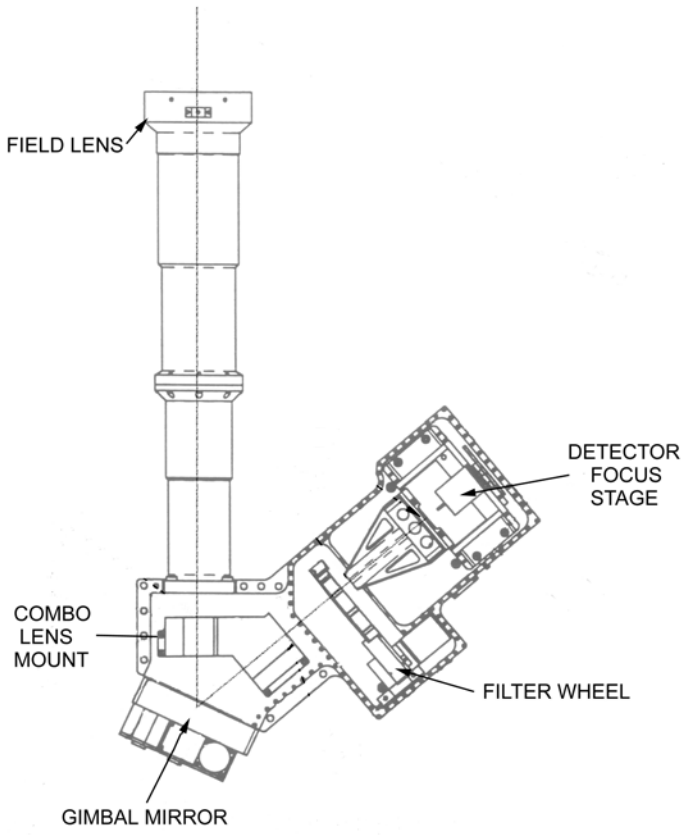

Fig. 8.6.1 Schematic Layout of the OIWFS

8.6.2 OIWFS Field Lens

The front tube of the OIWFS Field Lens Assembly must be removed preparatory to removal of the preslit bench (or further disassembly of the instrument, see 8.4.5), but the only justification for removal of the lens itself would be cleaning or replacement in the event of damage.

8.6.2.1 Preparation and Special Tools

M6 ball driver with long extension
Vacuum Chuck

WARNING: Removal or installation of the lens should be performed in a clean environment by a person experienced in handling delicate optics! Gloves and a face mask must be worn. Use of a vacuum chuck to handle the lens itself is strongly recommended. Refer to section 8.7.1 for optics handling procedures.

8.6.2.2 Preparatory Procedures

Follow the procedures through 6E in Section 8.4.5 to remove the front section of the OIWFS field lens tube 89-NOAO-4200-0078.

8.6.2.3 OIWFS Field Lens

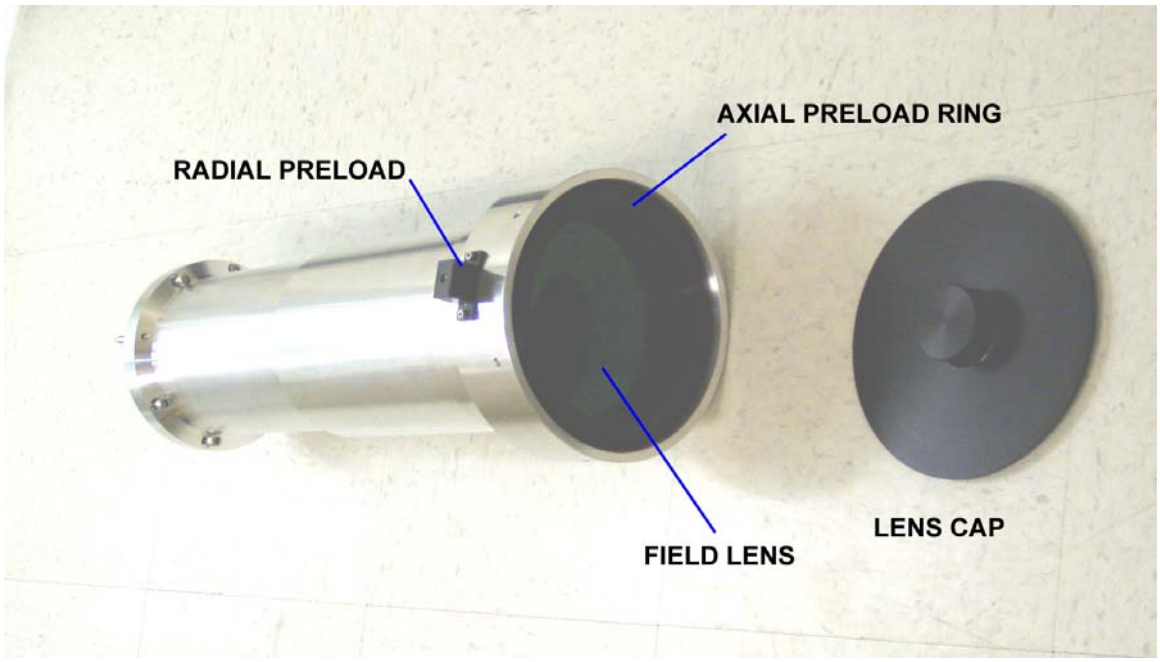

Fig. 8.6.2 Front view of the OIWFS Field Lens Tube, showing the preloads and the removable lens cap.

Removal of the OIWFS Field Lens

Remove the front section of the field lens tube (8.4.5) and take it to a clean area for removal of the lens. Refer to Fig. 8.6.2.

Remove the two M3 screws holding the radial preload and slide the radial clamp out.

Remove the lens cap.

Unscrew the six M3 button head screws securing the axial preload stop to the lens tube.

Carefully hold the preload stop in position while removing the last screw.

Remove the axial preload stop, the three springs, and (carefully) the axial preload ring without touching the surface of the lens.

Use a vacuum chuck to lift the lens out of its cell and place it on a clean surface. A sheet of lens paper between the chuck and the lens will protect the lens surface (section 8.7.1).

Installation of the Field Lens

Installation of the field lens is the reverse of the removal procedure. When installing the lens with the vacuum chuck, ensure that the edge of the lens is aligned with the radial seats and that the lens seats fully on the three axial supports before releasing the vacuum. Be careful not to touch the lens surface during the installation of the axial preload ring.

Complete the installation by following the procedures in 8.4.5 for reassembly of the field lens tube.

8.6.2.4 Completion

- Remove the protective cap on the lens tube
- Install the Foreoptic Module Assembly (8.4.5)
- Install the front active shields (8.4.4)
- Install the front dewar shell (8.4.3)
- Pump out the dewar, including dry nitrogen purge (4.2.2)

8.6.3 Filter Wheel and Detector Focus Assembly

These two mechanisms will be covered in the same section because they can both be accessed without the need to remove the OIWFS bench from the main GNIRS bench. In addition, **it is necessary to remove the filter wheel in any case prior to removal of the detector focus assembly.**

8.6.3.1 Preparation and Special Tools

Short 3/32 flat-end allen driver and standard 3/32 allen wrench
Long shaft 5 mm allen ball driver
Shorting plug for OIWFS detector connector

NOTE: The mounting screws for the electrical connectors are 4-40 and require a 3/32 allen wrench

WARNING: Exercise appropriate ESD protection when working around the OIWFS detector. Utilize a personal grounding strap during any steps when the shorting plug for the detector must be taken off.

Follow the mechanism removal procedures through 8.5.1 to access the OIWFS bench. The OIWFS bench may or may not be removed from the GNIRS bench, depending on the requirements of other repair tasks.

8.6.3.2 OIWFS Filter Wheel

Removal of the OWIFS Filter Wheel

Remove the large number of M4 and M2.5 screws securing the top cover of the OIWFS, remove the cover itself (ensuring that no cables are snagged on the projections) and set it aside.

Using a 3/32 allen wrench, loosen the 4-40 screws holding the two connectors to the inside of the OIWFS bench. Use the short driver to remove the screws.

Remove the three M6 screws securing the filter wheel to the bench using a long-shafted 5 mm driver. The screws may be temporarily left in place.

Carefully lift the filter wheel assembly straight out of the bench, ensuring that the connectors do not catch on anything. Remove the three M6 screws.

Unless the filter assembly will be reinstalled shortly, remove the brass shims and store in a safe place.

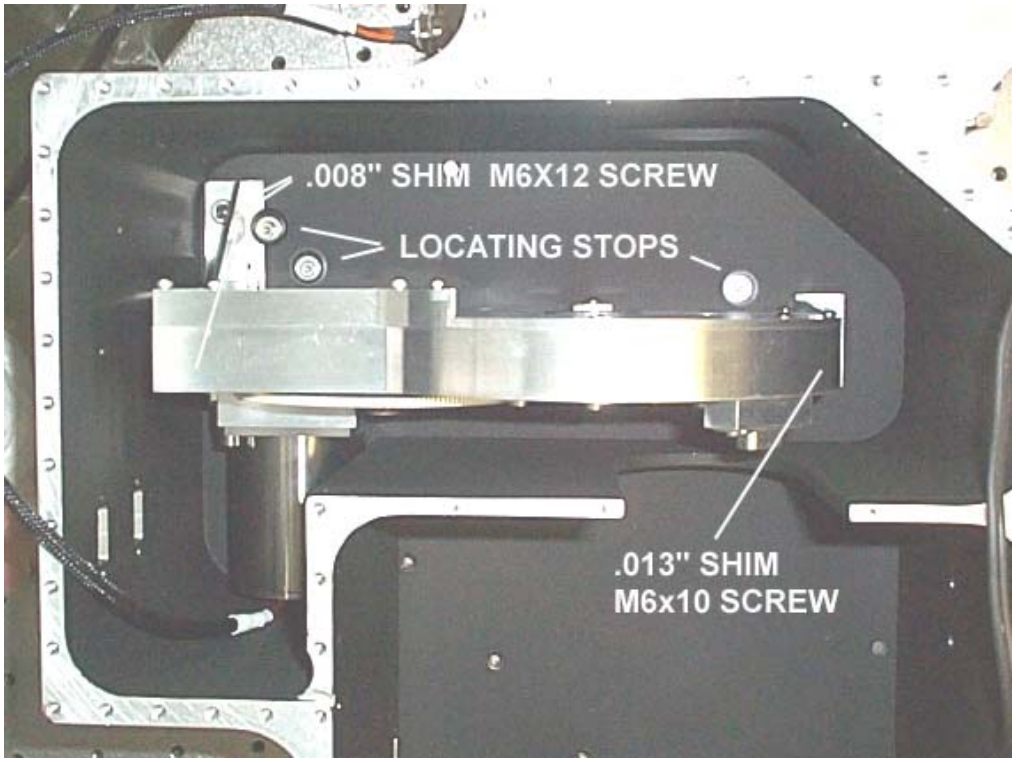

Fig. 8.6.3 Filter Wheel Installed in OIWFS.

Installation of the OIWFS Filter Wheel

NOTE: If both the filter wheel and detector focus assembly have been removed, the detector focus assembly must be installed before the filter wheel.

Ensure that the filter wheel cavity is clean.

Carefully lay the brass shim plates around the three tapped holes. The two holes on the motor side of the filter wheel require a single .008" shim each, and the single hole on the other side requires .013" (.008 and .005 together). See Fig. 8.6.3.

Install the M6 bolts in the filter wheel mount feet prior to installation, as space is limited.

NOTE: The two holes on the motor side use M6X12 screws, the hole on the far side must use M6X10 to avoid the screw projecting through the bottom of the bench.

Carefully lower the filter wheel assembly into the cavity and push it against the three locating washers on the bench. Tighten the three M6 screws finger tight, ensuring that the shims had not slipped during the installation. Make sure that the filter wheel is still firmly against the locating washers, and torque the screws, beginning with the one on the far side (away from the motor).

Install the connectors for the motor (742-J6) and Hall sensor (741-J3), using 4-40 screws with a lock washer.

8.6.3.3 Detector Focus Assembly

Removal of the Detector Focus Assembly

Prior to this, the filter wheel must be removed (8.6.3.2) and stored in a safe place.

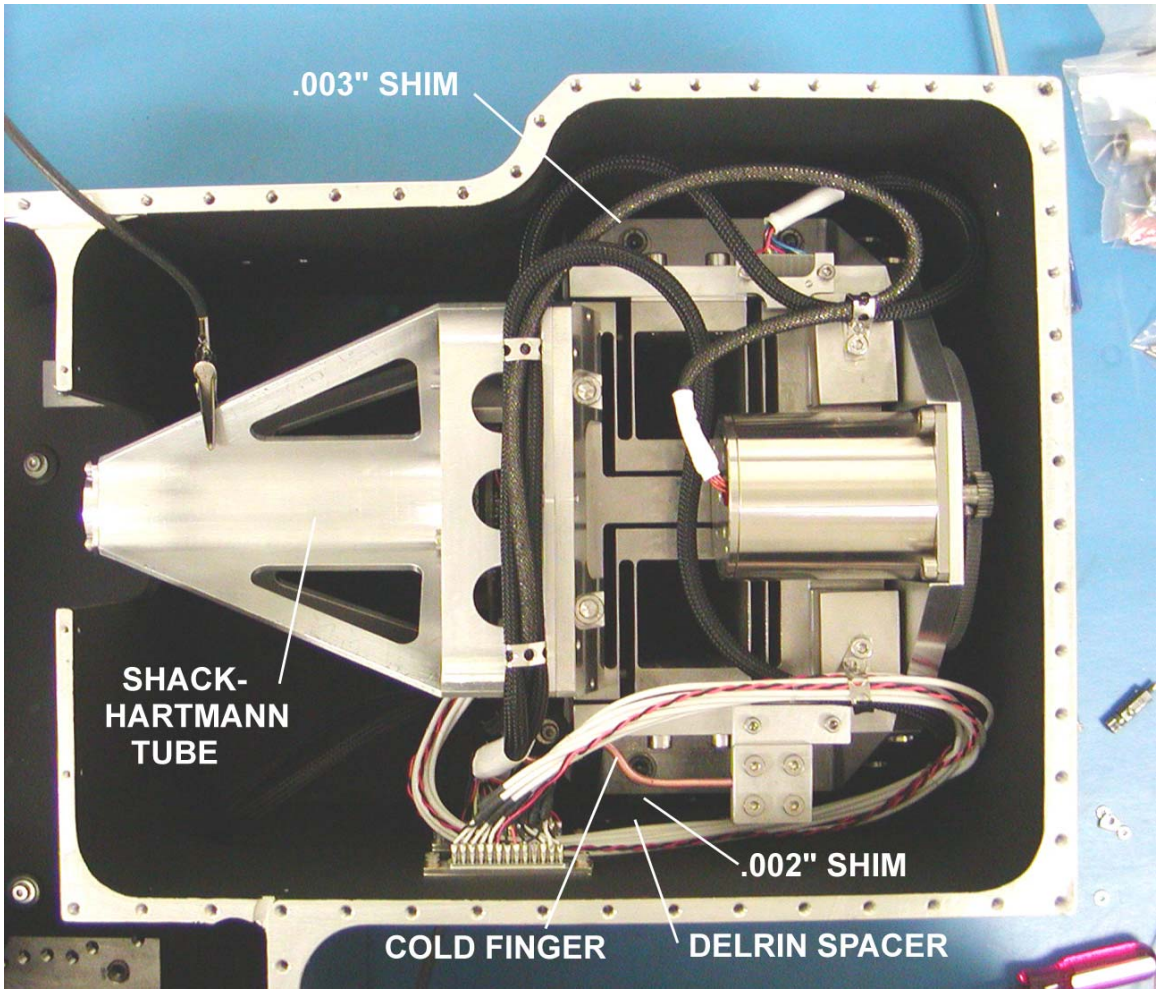

Fig. 8.6.4. Detector Focus Assembly in the OIWFS Bench. Note the clamps used to dress the cables. Brass shims go under the focus assembly feet at the two locations noted.

Remove the 4-40 screws holding the detector connector to the inside of the OIWFS bench and those holding the grounding cable in place. **Ensuring that both you and the grounding cable are grounded to the bench**, pull the connectors apart and reattach them external to the bench.

Remove the four stainless cable clamps, two on the Shack-Hartmann detector stage, two on the focus drive. Replace the two M4 screws on the focus drive afterwards. Ensure that the cables are free and will not snag when the focus assembly is lifted out of the bench.

Remove the four M6 screws holding the focus assembly to the OIWFS bench. Lift the assembly out of the bench and place it on the top wall of the bench or on a lab jack just outside the bench. **The cables are too short to permit the focus assembly to be put on the table outside the bench (Fig. 8.6.5).** It may be helpful to have a second person hold the assembly.

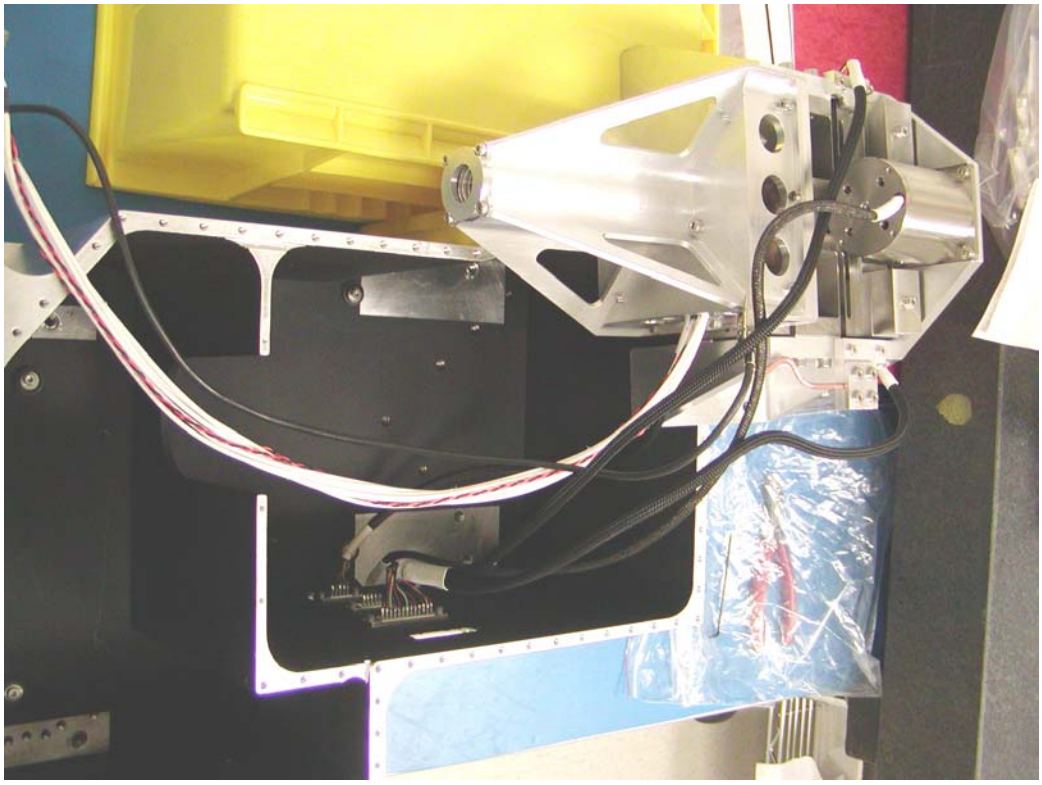

Fig. 8.6.5. Detector Focus Assembly removed from the OIWFS bench prior to unbolting the remaining electrical connectors. The cables are of insufficient length to permit the focus assembly to sit on the table outside the bench.

Remove the 4-40 screws holding the remaining three connectors to the inside of the OIWFS bench and carefully move the assembly out of the bench, taking care not to sit it on any of the cables. **While grounded, remove the grounding clip from the OIWFS bench and reattach it to the frame of the Shack-Hartmann tube.**

Removal of the OIWFS Detector Assembly from the focus drive is covered in Section 8.8.2.

Installing the Detector Focus Assembly

Set the detector focus assembly on top of the OIWFS bench so the cables can reach the connector ports (Fig. 8.6.5). Using 4-40 screws with a lock washer, install the detector temperature cable (744-J2), focus motor cable (742-J5), and Hall sensor cable (741-J3).

Place the two brass shims over the two holes for the front of the focus assembly and the Delrin shim on the side screw (Fig.8.6.4). Note that the left and right shims are .002” and .003”, respectively. Place the four M6X16 screws in the feet of the assembly and very carefully lower it into the OIWFS bench, being careful not to displace any of the shims. Push the focus assembly against the two locating washers in front and the Delrin shim on

the side and secure the four M6 screws. Tighten the two screws on the front of the focus assembly first.
Dress the cables as shown in Fig. 8.6.4 and install the four cable clamps, two on the M4 screws near the rear of the focus assembly, two on the remaining M3 screws securing the Shack-Hartmann assembly to the focus assembly.

Check that both you and the bench are grounded, and remove the grounding plug from the detector cable. Install the connector to the inside of the bench (740-J3) and reconnect the grounding plug. Secure the connector to the inside with two 4-40 screws.

Install the filter wheel (8.6.3.2).

8.6.4 Gimbal Mirror Assembly

If only the gimbal mirror must be removed, it is not necessary to remove the OIWFS bench cover. However, the entire OIWFS bench must be removed from the GNIRS bench.

Carry out the steps in section 8.5.1 to access and remove the OIWFS bench from the GNIRS bench.

Fig. 8.6.6 Gimbal Mirror Assembly

Removal of the Gimbal Mirror Assembly

Unbolt the OIWFS bench from the GNIRS bench and carry it to a work table. This should be done by two people.

Remove the screws holding the connector plate to the OIWFS bench.

Remove the four M6 screws holding the gimbal mirror to the OIWFS bench. The gimbal assembly is pinned to the bench, but a second person should hold the assembly in place when the last screw is removed.

Carefully extract the gimbal mirror assembly from the bench, taking care with the counterweight ring. The assembly may be placed on the bench.

If the motors or gearboxes are to be disassembled, place the gimbal assembly face down with the edges resting on two metal blocks sufficient to clear the counterweight.

Further disassembly of the gimbal mirror is beyond the scope of this manual. Refer to the OIWFS manual for additional details.

Installation of the Gimbal Mirror Assembly

The installation procedure is the reverse of the removal procedure. Fit the assembly to the bench, ensuring that the pins engage. Install and torque the four M6X16 screws. Reinstall the connector plate on the bench.

8.6.5 Combo Lens Mount

Preparation is the same as for the Gimbal Mirror. The OIWFS bench must be removed from the GNIRS bench, but the top cover can be left on.

- Carry out the preparatory steps in 8.6.4.
- Remove the OIWFS bench from the GNIRS bench and set it on a table inverted (top cover down). Ensure that it is not resting on the gimbal mirror connector plate or any of the heating resistors.

Removal of the Combo Lens Mount

Remove the five M6 screws holding down the combo lens mount. A long extension driver is required to reach the screws. Lift the combo mount out of the OIWFS bench.

Further disassembly of the lens mount is beyond the scope of this manual. Refer to the OIWFS manual for additional details.

Installation of the Combo Lens Mount

Place the two gauge blocks (89-NOAO-4203-1191 and 89-NOAO-4203-1198) between the lens mount and the bench (Fig. 8.6.7) and push the mount tight against the blocks. Tighten down and torque the five M6 screws.

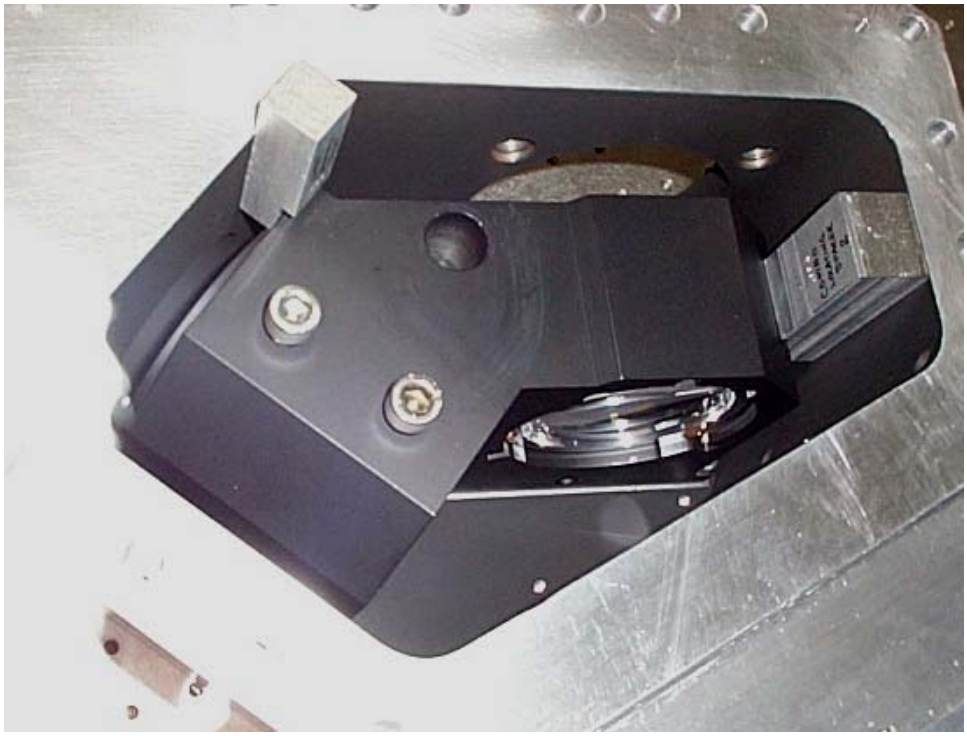

Fig. 8.6.7. Installation of the Combo Lens Mount using the Gauge Blocks.

8.6.6 Installation of OIWFS Bench

If the OIWFS bench cover had been removed for access to the filter wheel or detector focus assembly, check that the mechanisms and connectors are properly installed and place the cover on the OIWFS bench. Install the large number of M4 and M2.5 screws securing the top. Because the top is slightly warped, it will be necessary to repeat the torquing procedure a couple of times to ensure that all screws are properly tightened.

Carry the OIWFS bench to the main bench and lay it in place. Install the M10 screws and torque down.

Remove any protective covering over the entrance to the OIWFS and install the rear section of the OIWFS field lens tube with four M12X35 screws.

Remake the electrical connections to the OIWFS.

8.7 Optics Removal and Installation

8.7.1 Procedures for Handling Optics

Removal of the GNIRS optical elements, except for the filters, is not a normal maintenance item and would be carried out only in the event of a serious event such as contamination or damage to one of the elements. With the exception of the entrance window and the OIWFS field lens, access to the optics requires significant disassembly of the instrument and removal of mechanisms or fixtures within the bench.

Alternatively, removal of the optical elements may be required in the event of damage to the mechanism itself. Disassembly of the mechanism hardware is beyond the scope of this manual and must be carried out using the assembly drawings as a reference (we strongly suggest referring to the assembly drawings prior to removal of any mechanism or optics in any case). A plan of action, including provision for testing any repaired mechanism, should be in place prior to beginning major disassembly of the instrument.

There are three general techniques for removal and installation of the GNIRS optical elements. Some, such as the gratings and prisms, are sufficiently accessible to be manually lifted out of their mounts. Others may be pushed out of their mounts using a "milkstool" covered with lens paper. The camera lenses and some of the large mirrors must be lifted from their cells; the only recommended technique is to use a vacuum chuck. These procedures will be described in detail below and they will be referenced in the following sections covering each of the optical subsystems.

General Safety Procedures

As always, common sense is the best guide to handling optics. However, many of the GNIRS optics require special cautions associated with their infrared properties which go beyond those required for more conventional optics.

- Optics should be handled only by personnel experienced in working with delicate optical elements.
- Work on the optics should be carried out in a clean environment, preferably in an optical flow bench with adequate work space.
- Powder-free latex gloves and a face mask must be worn when handling optics.
- Infrared optics, particularly BaF_2 and CaF_2, are extremely delicate and can crack or cleave under mechanical or thermal shock. In addition, the BaF_2 lenses are very heavy (almost twice the density of glass).
- Optics should be cleaned, if necessary, by blowing contaminants off with pressurized N_2 or dried filtered air. The used of canned cleaners, such as an Effaduster, is not recommended, since the propellant can project a cold jet which can crack crystalline optics if it contacts the surface.
- If absolutely necessary, the lenses and non-metallic mirrors can be cleaned by "drag wiping" with a lint-free optical cloth moistened with reagent grade ethanol or methanol. Do not use acetone, as it will leave streaks on the surface.

- The gratings and "Alumiplate" metal mirror surfaces cannot be touched or cleaned by any physical contact process.

Handling Optics with the Vacuum Chuck

A vacuum chuck is strongly recommended for the removal and installation of the large optical elements in GNIRS, as it is the only safe tool for handling delicate optics in the close-fitting lens and mirror cells. The vacuum chuck used at NOAO is shown in Fig. 8.7.1. Briefly, it consists of a mechanical vacuum pump connected through a valved flexible line to a Delrin suction cup with a rubber seal. The bleed valve on the handle is used to vent the vacuum once the optic is in place.

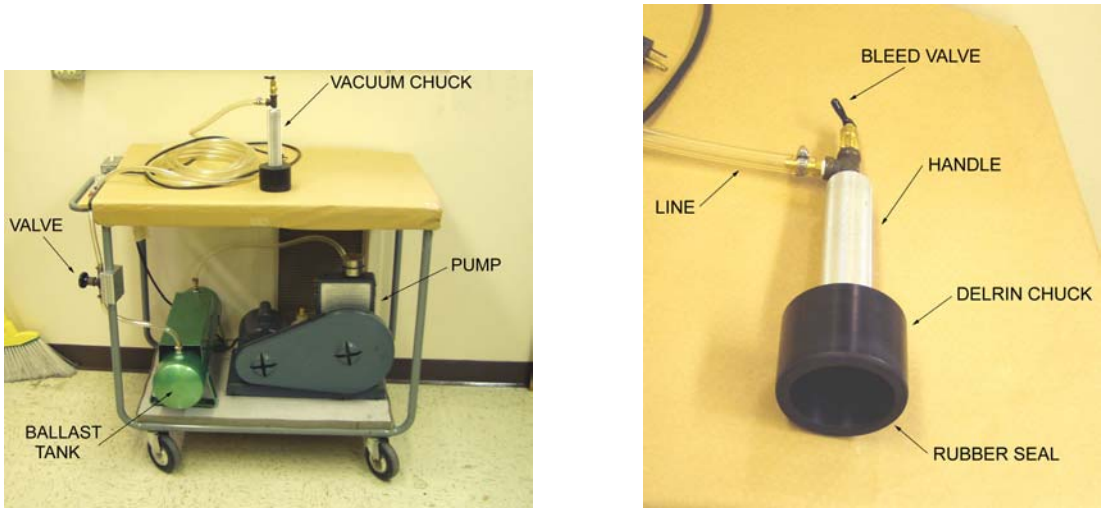

Figure 8.7.1 Left: Vacuum chuck used at NOAO, with mechanical pump, ballast tank, and valve with pressure gauge. Right: Closeup of vacuum chuck

To lift a lens using the vacuum chuck, lay a piece of lens tissue on the top surface of the lens and place the vacuum chuck onto the tissue. The tissue protects the antireflection coating on the lens from possible abrasion damage. Mirrors may be lifted (**from the back only**) without the lens tissue. Open the valve on the vacuum pump until a vacuum of at least 90% of the ambient pressure is attained.

When removing a lens from its cell, carefully lift the lens straight up about 2 mm and ensure that it is securely held by the vacuum chuck. Continue to lift the lens straight out of the cell and lay it down on a piece of clean tissue on the table (it is a good idea to keep one hand a few cm under the lens while moving it well above the table surface). Once the lens is safely on the table, close the valve on the vacuum pump and vent the line. Carefully lift the vacuum chuck off the lens.

Installation of a lens is the reverse of the removal procedure. Both the lens and the cell should be clean. Use extreme care in blowing any dust off the lens; only filtered and dried air or nitrogen gas should be used. The use of canned cleaner, such as Effaduster, is

not recommended, since it is possible to get a jet of very cold propellant, which can thermally shock and crack IR lens materials.

Place lens tissue on the surface of the lens and pick it up with the vacuum chuck. Carefully lower the lens into the barrel until it is securely on all three axial seats. Release the vacuum chuck and carefully remove the lens tissue.

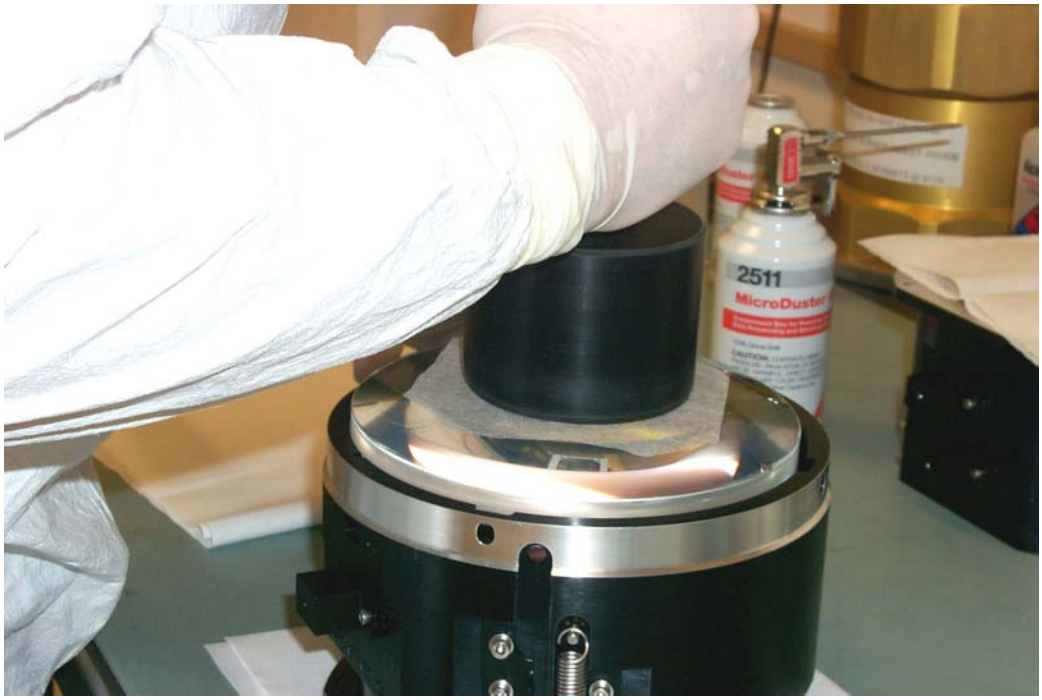

Fig. 8.7.2 Removing Lens 1 from the Short Red Camera with the vacuum chuck.

Use of an Optical "Milkstool"

A "milkstool" is simply a cylinder covered with lens paper which is used to push an optical element out of its cell. This technique can be used only for lightweight cells containing a single optic, such as the entrance window or lens 3 in the Long Blue Camera. The cylinder must fit within the clear aperture of the cell and be at least as high as the cell itself (but not too much higher). Place the cylinder on the workbench. Ensure that all of the axial and radial retainers have been removed, so that the optic is free within its cell. Lift the cell and center it over the milkstool, then slowly lower the cell until the lens is dislodged from its seats. Continue to lower the cell until it is sitting on the table. Lift the optic off the milkstool and lay it on a piece of optical tissue.

Installation is the reverse of this procedure. Lay the lens cell on the workbench and place the milkstool in the center of the cell. Carefully pick up the optic and place it on the milkstool, properly centered. Slowly lift up the cell so that the optic slides into the cell. Ensure it is properly seated, then continue to lift up the cell and place it on the table.

8.7.2 Camera Lenses and Mirrors

8.7.2.1 Preparation and Special Tools

Any work on the camera optics requires that the camera turret be removed from the bench and the appropriate camera barrel(s) be removed from the turret. Refer to section 8.5.6 for coverage of these procedures and to section 8.7.1 for instructions on operation of the vacuum chuck.

Spring tensioning tool
Vacuum chuck
Cylinder, approx 25 mm dia, 75 mm long (Long Blue Camera Lens 3)

All of the lenses in the four cameras share a common mounting technique. This manual will thus describe the removal/installation procedure only once (for all but the third lens in the LBC). The overall procedure for a particular camera lens will fall into one of three general operations.

The short red and blue cameras each have four lenses, two in each of two separable barrels. The long red and blue cameras have two large lenses in a barrel which can be separated from the rest of the camera. In addition, the long blue camera has a small third lens in a cell mounted on the rear barrel. The two long cameras also have two flat mirrors installed in the rear barrel.

Removal of the second lens in a given barrel (camera lenses 2 or 4) requires removal of the first lens as well. Access to lenses 3 or 4 requires removal of the front barrel. We recommend separating the barrels prior to removal of any lens, since this reduces the risk of inadvertent damage to the lenses in the other barrel.

Note: The GNIRS camera lenses are both quite heavy and very fragile. BaF_2, in particular, is almost twice as dense as fused silica and is very susceptible to cracking under mechanical or thermal shock. The only safe technique for removal or installation is to use a vacuum chuck. The following procedure should be performed only by a person experienced in handling delicate optics wearing powder free latex gloves and a dust mask, preferably on a clean bench. A second person should operate the valve on the vacuum chuck.

8.7.2.2 Lens Removal and Installation

General Lens Removal Procedure

The lens barrel should be on a clean bench with the forward section facing up.

Remove the two M3 screws holding in the radial preload spring and carefully remove the preload from the camera barrel.

Using the spring tension tool, remove the three axial preload springs. **Gently hold the preload ring against the lens with one hand to prevent the ring from dropping onto the lens when the last spring is removed.**

Use a small allen wrench to unscrew the three pins on the axial preload ring. **Continue to hold the preload ring against the lens with one hand to prevent banging the ring against the lens.** Remove the three pins and set aside.

Using one's fingers against the inside of the axial preload ring, carefully lift the ring out of the barrel. The lens should now be sitting freely on the axial seats.

Lay a piece of lens tissue on the top surface of the lens and place the vacuum chuck onto the tissue. Remove the lens using the procedure described in 8.7.1. Refer to Fig. 8.7.2.

General Lens Installation Procedure

Installation of a lens is the reverse of the removal procedure. Both the lens and the cell should be clean. Use extreme care in blowing any dust off the lens; only filtered and dried air or nitrogen gas should be used.

Place lens tissue on the surface of the lens and pick it up with the vacuum chuck. Carefully lower the lens into the barrel until it is securely on all three axial seats. Release the vacuum chuck and carefully remove the lens tissue.

Lower the axial preload ring onto the lens and carefully rotate until the tapped holes for the spring pins are aligned with the holes in the barrel. Thread the three pins into the holes until finger tight. Holding the ring against the lens, tighten the pins using a small diameter allen wrench.

Hang the three springs on the spring pins. Again holding the preload ring against the lens, use the spring tensioning tool to stretch the springs over the tensioning posts.

Install the radial preload. Tighten the two M3 screws evenly to keep the preload normal to the lens.

8.7.2.2.1 Camera Lenses

Place the camera front end down on a clean bench. Remove the six M4 screws securing the front and rear camera barrels and separate them. Set aside the baffle between the two barrels.

Lens 1 – Set aside the rear barrel. Lay the front barrel front end up on the bench and remove lens 1.

Lens 2 – Remove lens 1 (above) and carefully wrap it up in optical paper. Remove lens 2.

Lens 3 – (short cameras only). Set aside the front barrel. Lay the rear barrel front end up on the bench and remove lens 3.

Lens 4 – (short cameras only). Remove lens 3 (above) and carefully wrap it up in optical paper. Remove lens 4.

8.7.2.2.2 Long Blue Camera Lens 3

Remove the small cell containing lens 3 from the camera and set the rest of the camera aside.

Remove the spring and axial preload ring .

Cover the 25 mm dia X 75 mm long cylinder with lens tissue and set it on the bench. Carefully lower the lens cell over the cylinder and push the lens out of the cell. When the empty cell is sitting on the table, lift the lens off the cylinder.

Installation is the reverse of this procedure.

8.7.2.2.3 Long Camera Mirrors

Remove the front barrel containing lenses 1 and 2. Lay the rear barrel on the bench with the back surfaces facing up.

Remove the screws securing the mirror clamp to the side walls of the rear barrel and lift the clamp out. The mirror is not preloaded on the sides within the cell.

Using the vacuum chuck, lift the mirror out of the cell and place face up on a piece of optical tissue in a clean plastic box.

Repeat for the second mirror, if both are to be removed.

8.7.2.2.4 Long Camera Fixed Fold Mirrors

These mirrors are in the Long Camera Fold Mirror Mount on the bottom of the GNIRS bench. The mirrors themselves can be removed from the Mirror Mount while it is affixed to the bench.

The bench must be removed from the instrument (8.4) and sitting on its cart with the Long Camera Fold Mirror Mount facing up (Orientation “A”, section 8.4.10).

Remove the six M4 flathead screws holding the back cover on the appropriate mirror(s). Lift the cover off, being careful not to lose the three springs which hold the mirror into the cell. Lay the cover and the springs aside.

Unscrew the two side preloads until the Delrin pads can be removed from the cell. It is not necessary to completely remove the preloads.

Use a vacuum chuck to lift the mirror out of the cell**.** Do not lay the mirror on its gold front surface. If the bench will be turned over for additional work, remove the baffle from the mirror cell.

Installation is the reverse of this procedure. Install the baffle if it had been removed, with the black painted side down (the mirror should rest against the unpainted, anodized side of the baffle).

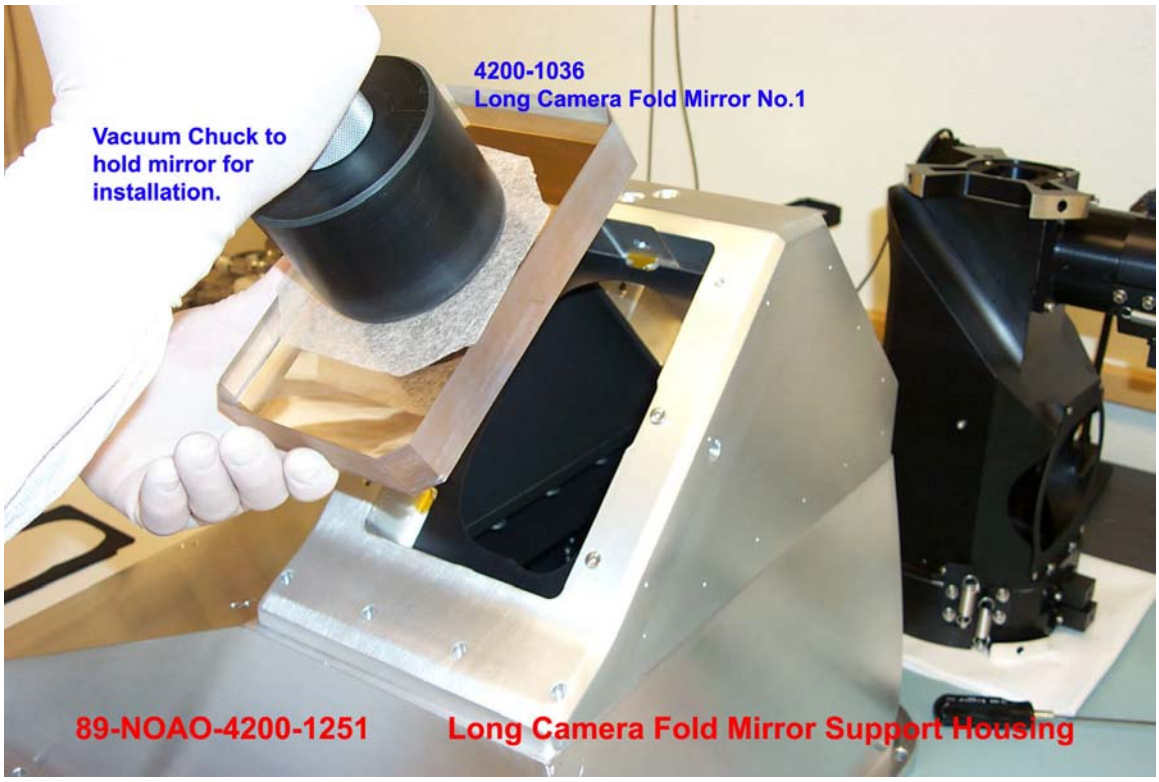

Fig. 8.7.3 Installing one of the long camera fold mirrors.

Use a vacuum chuck to install the mirror in the cell. The end with the single piece of Kapton tape should be oriented towards the apex of the "doghouse".

Install the two Delrin pads and advance the ball plunger preloads so the ball engages the detent in the pad. A piece of tape can be used to maneuver the Delrin pad in the narrow space between the mirror and the edge of the cell. Once the preload is installed, compress it lightly (about ¼ turn of the screw).

Put the three springs in the cover and install, ensuring that the springs do not fall out of the recesses in the cover. The springs should push against the Kapton tape pads on the back of the mirror. Install and torque the six M4 screws.

8.7.3 Pickoff Mirror

The pickoff mirror is located in the front of the Foreoptics Module Assembly (Fig. 8.7.4) and can be accessed by removal of the front shell (8.4.3) and front Active Radiation Shield 11(8.4.4). *It is not necessary to remove the Foreoptics Module Assembly itself from the preslit bench.* The pickoff mirror is a gold-coated replica which must be handled with great care; the sharp edges are susceptible to chipping. Wear latex gloves when handling the mirror.

NOTE: When the instrument is sitting horizontally on its feet, the Offner assembly is inverted and the pickoff mirror must be removed from the bottom.

Remove the three brass screw covers on the Offner with a slot screwdriver. Remove the access cover on the side of the Foreoptics Module opposite the Offner primary (Fig. 8.7.4).

Remove the three spring-loaded shoulder screws which secure the pickoff mirror, holding the mirror in place with one hand. Once the screws are removed, lower the mirror from the Foreoptics Module Assembly.

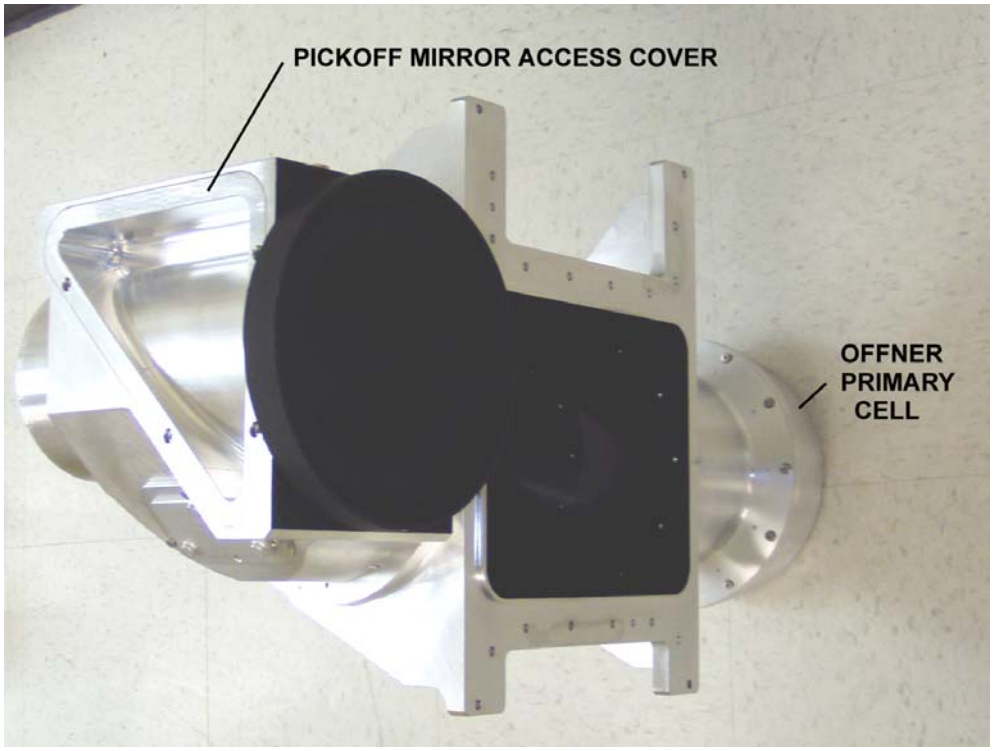

Fig. 8.7.4 Foreoptics Module Assembly, showing access cover for pickoff mirror

8.7.4 Foreoptics Module Assembly and Offner

The entire Foreoptics Module Assembly is removed from the preslit bench as part of the main bench removal procedure (8.4.5). One can then remove the optics from the Offner assembly on a workbench. It is also possible to remove the Offner optics with the Foreoptics Module Assembly still mounted on the preslit bench in the event that no further disassembly of the instrument is required. The optics removal and installation procedures are the same in either case.

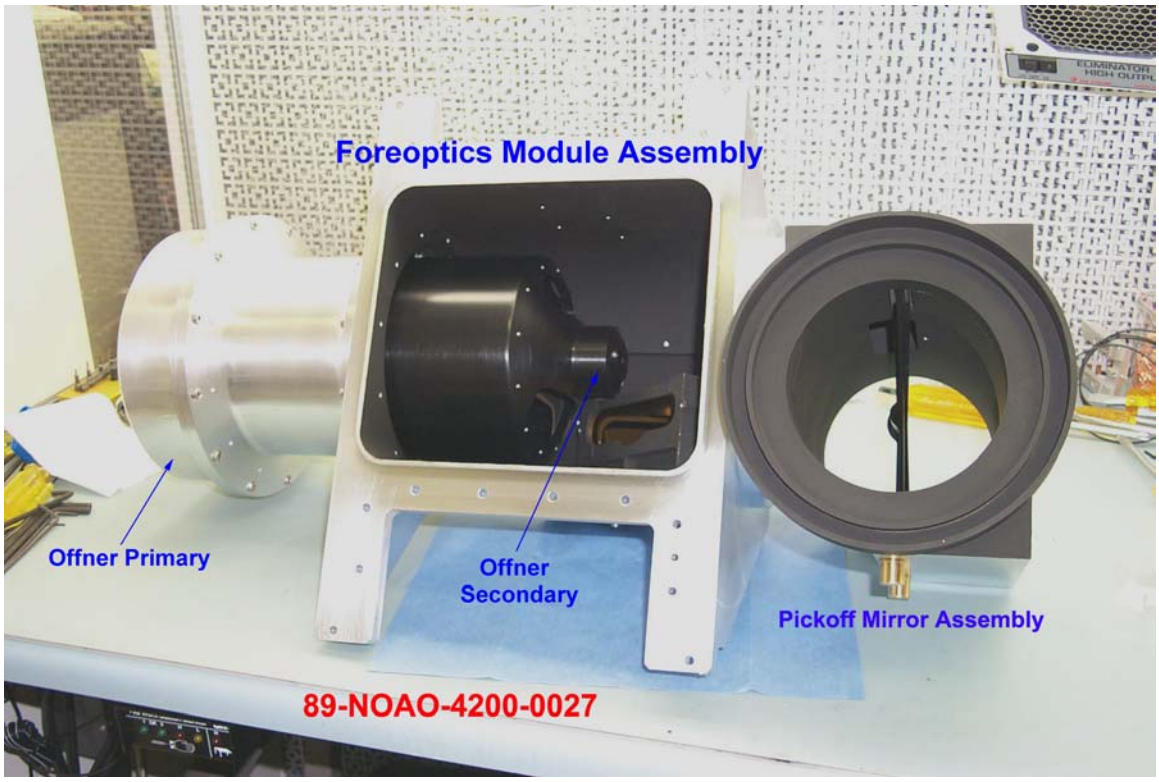

Fig. 8.7.5 Foreoptics Module Assembly

8.7.4.1 Offner Input Fold Mirror

The input fold mirror is held into the Foreoptics Module Assembly by three captive M4 screws. Loosen the screws and carefully pull the mirror cell out. NOTE: The .005" shim on one of the long sides of the mirror must be retained for the reinstallation procedure.

Fig. 8.7.5. Offner input fold mirror (left) and output fold mirror (right).

8.7.4.2 Output Fold Mirror

Unscrew the six captive M4 screws holding the output fold mirror cell into the Foreoptics Module Assembly. Gently pull on two of the screws to unseat the dowel pins. Back the mirror cell out of the housing, removing the side towards the main bench first to clear the mirror clips.

To remove the mirror, lay the fold mirror assembly on a bench with the reflective surface facing down. Remove the two clips holding the mirror in place. Invert the assembly and remove the mirror by hand.

Installation is the reverse of the above procedure.

8.7.4.3 Offner Primary

NOTE: Both the Offner primary and secondary are gold-coated diamond turned mirrors on Alumiplate. The Alumiplate surface is extremely soft and easily damaged. Although the gold coating is "protected", one should avoid touching or attempting to clean the surface by wiping.

Removal of these mirrors is not a normal maintenance procedure and carries the risk of misalignment when they are reassembled. Only an experienced optical technician should attempt this procedure.

If the only the Offner primary is to be removed, remove the 12 M4 screws holding the primary cell 89-NOAO-4200-1073 onto the Foreoptics Module Assembly 89-NOAO-4200-0027. If both the primary and secondary must be accessed, remove the M4 screws at the middle of the assembly to take off the Offner Assembly 89-NOAO-4200-0032, then remove the12 M4 screws holding the primary cell. Refer to Fig. 8.7.6.
Lift off the Offner primary cell and place it in a plastic box for safekeeping.

Removal of the primary from the cell must be done with extreme care, preferably on a flow bench. Lay the primary cell face down on a clean sheet of optical paper. Carefully and evenly unscrew the three M4 brass screws securing the primary until the primary is resting on the bench, then lift off the cell. Pick up the primary and place it in a plastic box face up.

8.7.4.4 Offner Secondary/ Cold Stop

Remove the 12 M4 screws holding the Offner Assembly 89-NOAO-4200-0032 onto the Foreoptics Module Assembly 89-NOAO-4200-0027. Take the Offner Assembly to a clean workplace, preferably a flow bench. Remove the 12 M3 screws holding the Offner Secondary Mount 89-NOAO-4200-1072 to the Offner Tube 89-NOAO-4200-1071. Remove the Secondary Mount, being careful of the baffle which sits in the Offner Tube. Remove the baffle 89-NOAO-4200-1388 from the Secondary Mount, taking care not to drop any of the 12 M3 screws onto the secondary mirror, which is exposed during this procedure. The secondary baffle/cold stop, which is held in place by three M3 screws, can then be removed.

If the secondary must also be removed, carefully loosen the single M2.5 screw securing it from the back.

Reassembly is the reverse of the above procedure. During this process, ensure that baffle 2, which sits in the Offner Tube, is properly aligned and seated. All subassembly parts in the Offner Assembly have marks to ensure the proper alignment.

8.7.5 Collimator Mirror Assembly

The collimator mirror assembly may be removed with the main bench installed in the instrument bulkhead; only the aft shell, aft bulkhead and active shields must be removed. Three procedures will be covered here: access to the compensating counterweights; removal of the collimator assembly; removal of the collimator mirror from the assembly.

8.7.5.1 Preparation and Special Tools

NOTE: The collimator mirror, like the Offner active mirrors, is a gold-plated diamond turned mirror on Alumiplate. The Alumiplate surface is extremely soft and easily damaged. Although the gold coating is “protected”, one should avoid touching or attempting to clean the surface by wiping. Removal of the collimator mirror is a very delicate procedure to be attempted only by experienced personnel in a clean area. Refer to section 8.7.1 for general safety procedures in handling optics.

Access the collimator mirror by removing the Aft Dewar Shell (8.4.2), Aft Bulkhead (8.4.3) and Aft Active Radiation Shield 1 (8.4.4).

8.7.5.2 Access to Compensation Weights

Unscrew the collimator end cap from the collimator assembly. Be sure to support it properly so it does not drop onto the collimator itself when it comes loose. The compensation weights are now accessible.

NOTE: Adjustment of the compensation is not a normal procedure and should be attempted only if the actual on-telescope performance gives reason to suspect the need for adjustment and an engineer familiar with the design and operation of the compensation system has been consulted.

8.7.5.3 Removal of Collimator Assembly

Remove the Collimator Assembly (section 8.5.2). Place it on a table forward end down.

8.7.5.4 Removal of Collimator Mirror

Remove the collimator end cap.

Loosen the small set screws holding the linkage posts into the collimator mirror support flexures and into the passive compensation flexure (Fig 8.7.7). These linkage posts are **extremely fragile** and must not be subjected to any bending force.

Remove the 6 M6 screws holding the compensator actuator assembly onto the collimator support ring. Very carefully lift the compensator actuator off the support ring, making sure the linkage posts slide freely out of the flexures. Remove the linkage posts and set them aside separately from the compensator actuator.

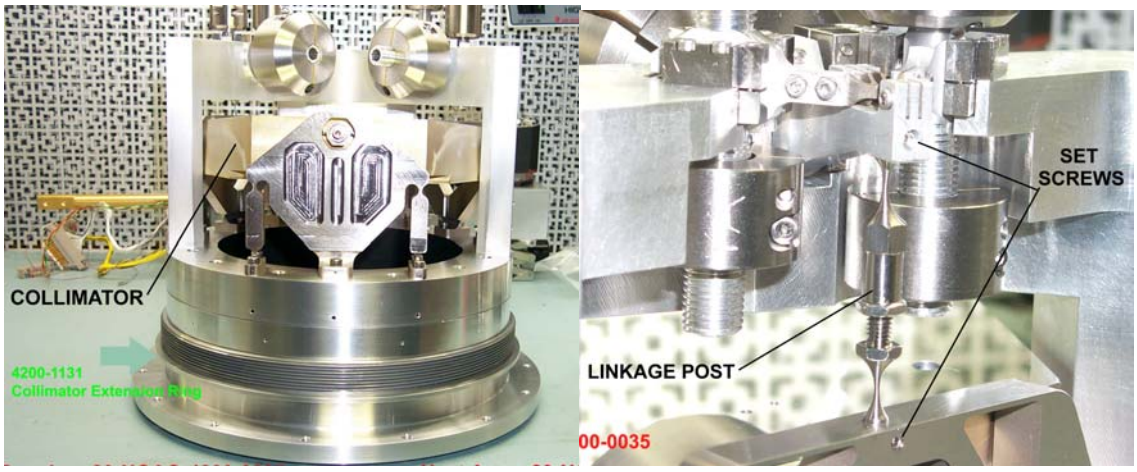

Fig. 8.7.7 Left: Collimator assembly after removal from the main bench. Right: Closeup of linkage between compensator and collimator flexure.

Unbolt collimator support flexures from collimator support ring and remove the collimator/flexure assembly.

Lay the collimator on a clean bench on its back and carefully remove the screws holding the flexures to the studs in the side of the collimator. Ensure that the studs do not come loose, as they are secured with Lock-Tite, and any loosening of these studs will result in uncorrectable collimator flexure and degraded spectrograph performance.

Installation is the reverse of the above procedure. When installing the compensator actuator assembly, it is necessary to first place the linkage posts into the flexure and then carefully lower the compensator actuation assembly, ensuring that the linkage posts fit into the appropriate holes. This must be done with extreme care. Once the compensator actuator assembly is bolted to the support ring, tighten the set screws securing the linkage posts, ensuring that they engage the detents in the posts.

8.7.6 Prisms

The four optical elements on the prism turret (three prisms and a mirror) are each held in place against locating seats on the back surface and on one side by spring-loaded masks, which also act as optical baffles. The spring retaining hooks have been adjusted to give the proper spring preload to keep the prisms in place in all orientations.

NOTE: Follow the optics handling procedures outlined in 8.7.1. Wear gloves and a face mask when working with exposed optics. The two dispersive prisms are SF57 glass, which is twice as dense as fused silica, and are thus quite heavy. The Wollaston prism consists of two separate elements in a cell, spaced by .001" shims.

8.7.6.1 Preparation and Special Tools

Access to the prisms requires removal of the main bench from the instrument and removal of the prism turret from the main bench.

Spring tensioning tool
89-NOAO-4203-0055 Prism Storage Fixture

8.7.6.2 Prism Removal and Installation

Remove the prism turret from the main bench (section 8.5.7) and install it in the storage fixture.

The procedure for removal and installation of any of the four optical elements is similar, so it will be covered only once. All optics utilize springs at three locations, two at adjacent corners, the third on the center of the opposite edge, to hold the element against the back supports. The two dispersive prisms have an additional spring in the cavity behind the element, which maintains lateral force against the side supports. This lateral support is built into the Wollaston prism cell.

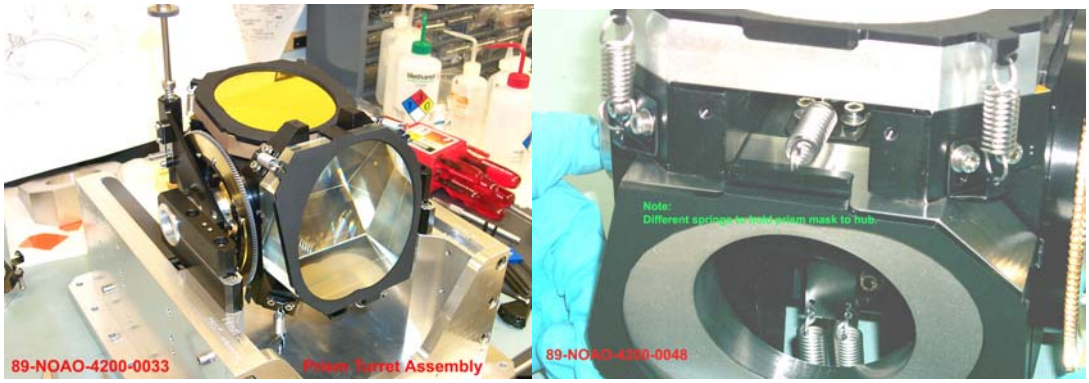

Fig. 8.7.8 Left: Assembled prism turret in the work fixture. Right: Closeup of the turret, showing the spring tensioned masks which hold the prisms in place.

Prism Removal

Rotate the prism turret so the element to be removed is on top, with a slight rotation towards the retaining seats so the prism will remain in place when the clamp is removed.

Using the spring tensioning tool, remove the springs from the tabs on the retaining mask. Hold the mask in place with one hand so it does not bang or slide on the prism/mirror surface. Carefully lift the mask off and set aside. Lift the prism/mirror off and set down on clean optical paper.

NOTE: The back surface of the prisms is aluminized, so one must be very careful not to scratch either surface. The safest procedure is to wrap up the prisms and store in the vendor shipping cases.

The Wollaston prism elements may be removed from the cell if necessary. Ensure that the original orientation is maintained. If the two elements are separated, keep the three .001" mylar shims, which will be required for reassembly.

Prism Installation

Rotate the prism turret so the prism will lay horizontally on the back seats. Make sure the springs are secured to the fixed mounts on the turret and will not interfere with the prism. Blow any dust off the prism, if necessary, and place on the turret with the aluminized side down; the reflective side of the mirror faces up. Carefully put the mask over the prism and hold it in place while using the spring tensioning tool to install the springs.

8.7.7 Gratings

The three gratings in the grating turret are each held in place against locating seats on the back surface and on one side by spring-loaded masks, which also act as optical baffles. The retaining screws are tightened to a specific degree to achieve the proper spring

preload to keep the gratings in place in all orientations. A spring provides lateral loading against the side seats.

NOTE: Follow the optics handling procedures outlined in 8.7.1. Wear gloves and a face mask when working with exposed optics. The gratings are extremely delicate and cannot be cleaned by other than blowing with dry nitrogen or clean dried air. Do not touch the ruled surface.

8.7.7.1 Preparation and Special Tools

Access to the gratings requires removal of the main bench from the instrument and removal of the grating turret from the main bench.

89-NOAO-4202-0048	Grating Turret Installation Fixture
89-NOAO-4203-0054	Grating Storage Fixture

8.7.7.2 Grating Removal and Installation

Grating Removal

Remove the grating turret from the bench (8.5.8) and install it in the storage fixture.

The procedure for removal and installation of any of the three gratings is the same, so it will be covered only once. Because the masks exert force against the side as well as the front of the gratings, they must be lifted to the side and up when being removed. We recommend a second person help keep the mask from rubbing against the grating during its removal and installation.

Rotate the grating turret so that the grating to be removed is on top in a horizontal orientation.

Fig. 8.7.9. The grating turret in the work fixture. The spring-loaded screws must be tightened to the proper compression to hold the grating in place.

One person should hold the mask in place while the second loosens the three screws. The mask can then be lifted up at one end while being slid back at the other, to the extent that the lateral spring permits, until the grating can be lifted off of its cell. Note the orientation of the arrow indicating the blaze direction on the top of the grating blank.

If another grating will be removed, reattach the mask with the three spring screws so the turret can be rotated without interference.

Grating Installation

Rotate the grating turret in its fixture so the grating seat is horizontal. If the mask had been in place, remove the three spring screws and lift the mask up and to the side so the grating can be installed. If the mask had been removed, attach the lateral spring and position the mask so the grating can be installed.

Place the grating in its cell, ensuring that the blaze arrow on the side of the grating blank is at the top of the grating turret. Lift the mask up and over the grating until the screws can be installed. It is best to have two people perform this operation, one to hold the mask, the other to install the grating.

Tighten the screws until the springs are preloaded to the proper compression. The compressed length of the springs is given on the assembly drawing 89-NOAO-4200-0055.

8.7.8 Acquisition Mirror

The acquisition mirror mounts on the Bottom Camera Cover (89-NOAO-4200-1153) and can be removed with the cover in place. In fact, any procedure requiring the cover to be removed (such as accessing the camera or prism turrets, see section 8.5.6) will involve removal and storage of the acquisition mirror assembly, since the cover cannot be removed with the acquisition mirror in place.

Like the input pickoff mirror, the acquisition mirror is aluminum with a gold-coated replica flat surface. It is susceptible to chipping and, like all of the optics, must be handled with care. Refer to section 8.7.1 for safe handling procedures for the optics.

Access to the acquisition mirror requires removal of the main bench from the instrument. The acquisition mirror assembly is not a robust item and must be installed in its special frame 89-NOAO0-4203-0060 after it is removed from the instrument (Fig 8.7.10)

If possible, the acquisition mirror should be in the retracted position (out of beam) for both removal and installation.

The acquisition mirror removal and installation is covered in section 8.5.5.

Fig. 8.7.10 Left: Acquisition mirror assembly with motor removed. Right: Acquisition mirror assembly installed in the storage fixture with the Plexiglas cover on the mirror. The screws hold the leadscrew nut to the mirror.

8.7.9 Entrance Window

Due to its exposed location, the entrance window is the optical element most likely to require cleaning or possibly replacement. Since the instrument must be brought up to ambient temperature and pressure to do this, we strongly recommend that the window assembly be removed from the instrument and the actual window replacement be done in a clean area. The window can be removed or installed directly from the cell with the instrument sitting on its legs, but this requires the use of a vacuum chuck at a 90° gravity vector and carries the risk of poor seating of the O-rings.

The window is CaF_2 with an antireflection coating. It must be handled with great care; refer to section 8.7.1 for safe handling procedures. Dust may be blown off with pressurized N_2 or dry, clean air; as with all crystalline optics, we recommend against the use of pressurized cleaners such as Effaduster because of the risk of thermal shock to the optic. Isolated spots can be cleaned by drag wiping using a lint-free cloth and reagent grade ethanol or methanol; do not use acetone. Cleaning of a large area should be attempted only after removing the window from its cell, as it is otherwise extremely difficult to avoid streaks or smudges.

8.7.9.1 Preparation and Special Tools

Other than removal of the environmental cover, no disassembly of the instrument is required. The instrument must be at ambient temperature and pressure prior to removal of the window.

Optician's "milkstool" 75 mm dia X 50 mm high

8.7.9.2 Environmental Cover and Window Cell Removal

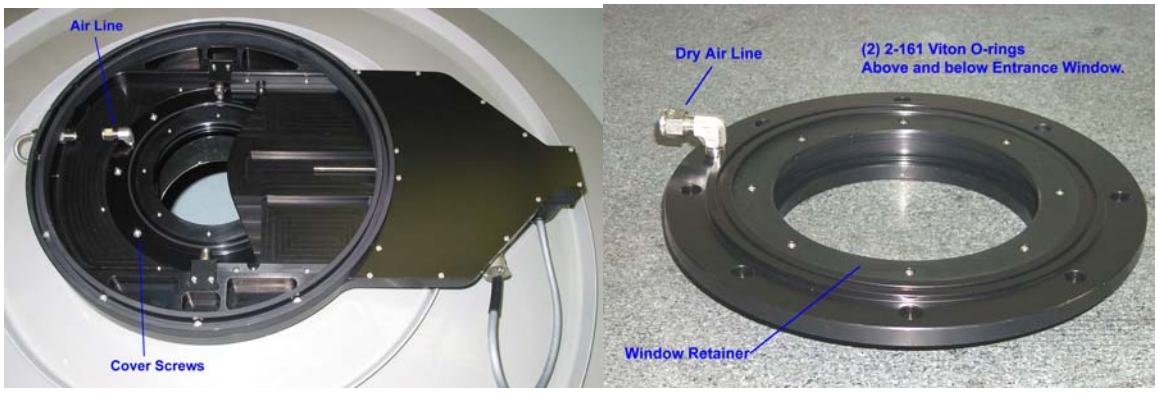

Fig. 8.7.11 Left: Environmental Cover on the front dewar shell. Dry air purge is not connected in this image. Right: Entrance Window cell.

Remove the pressurized air and motor connections to the environmental cover.

Loosen the Nupro fitting on one end of the short pressurized air line between the environmental cover and the window cell.

Remove the 8 M3 button-head screws holding on the environmental cover. This requires manually opening the cover partially to access some of the screws. Lift the environmental cover off while sliding the free end of the short air line out of its fitting; set the cover aside.

Remove the window cell from the front dewar shell.

Tape a piece of clean plastic sheet over the hole in the front dewar shell. We recommend keeping a modest flow of N_2 gas into the vacuum/vent port, so there will be a constant flow out of the window port.

8.7.9.3 Removing/Installing the Window

This is best carried out in a clean area suitable for working with optics. Observe precautions for handling delicate optical materials.

Removal of the Window

Remove the M3 screws holding down the window-retaining ring. Lift the ring off the window and set aside. If the front O-ring (which provides a soft contact, not a vacuum seal) remains on the window, lift it off.

Lift the window cell up and center it over the "milkstool". Lower the cell and gently push the window out of its cell. Once the cell is sitting on the table, lift the window off and lay it on a piece of optical paper. Clean or replace the window as needed.

Installation of the Window

Ensure that the cell is clean and the vacuum O-ring has no foreign material on it. The window should also be clean and free of dust or lint.

Lay the cell on the table and place the "milkstool" in its center. Place the window onto the "milkstool" with the arrow marking on the edge pointing down (the flat surface should be on the instrument side). Lift up the cell until the window seats evenly against the O-ring. Set the cell aside on the bench.

Lay the second O-ring on the top of the window so it is centered. Orient the window retaining ring so the triangle marking aligns with the marking on the window cell and place it over the O-ring so the O-ring seats in the groove in the back of the retaining ring.

NOTE: The window cell is beveled to mate with the environmental cover, so the retaining ring may appear to be tilted when it is in fact properly seated. Secure the window-retaining ring with the M3 screws. Take up on the screws evenly and do not overtighten them.

8.7.9.4 Installation of the Environmental Cover

This is the reverse of the installation procedure. Remove any protective cover over the window hole and check that the O-ring and mating surface are clean. Turn off the flow of N_2 into the instrument to avoid pressurizing it once the window is installed.

Install the window cell onto the front shell.

Install the environmental cover onto the window cell, making sure that the short air line feeds into the Nupro fitting on the window cell. Attach with the 8 M3 button-head screws. As in the installation procedure, it will be necessary to manually adjust the position of the environmental cover slide to access all of the screw locations.

Tighten the Nupro fitting on the short airline connection and reattach the clean air and motor power cable.