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Chapter 1
General Information

There are two versions of the Osmic Confocal Optic, a Blue version and a Green Version. The main differences between the two versions are in the device used to couple the shutter and the optic housing, the length of the beam tunnel and the location of the helium port. These differences will be labeled Blue optic or Green optic where applicable.

This chapter describes, in general terms, the components necessary for a mirror alignment. The components checked during each alignment procedure are listed below.

- Spring-loaded coupling hood (Blue optic)
- Adjustable beam tunnel (Green optic)
- Osmic confocal optic
- Fixed beam tunnel
- Helium purge control box
- Collimator and translation assembly
- Beam tunnel and support base
- PIN diode and meter
- \phi\text{-axis}
- Pinhole jig
- Microscope
- Area Detector or DCU (Data Collection Unit)

1.1 Spring-loaded Coupling Hood (Blue Optic)

\textit{NOTE:}

All documentation is written pertaining to a right port optic assembly. Differences for a left port optic assembly will be noted where applicable.

The spring-loaded coupling hood, shown in Figure 1-1, secures the optic housing directly to the shutter using a spring-loaded coupling hood set at an angle of 6°.
1.2 Adjustabe Beam Tunnel (Green Optic)

The adjustable brass beam tunnel, shown in Figure 1-2, ensures the middle of the optic housing is set at an exact distance of 9.45 inches, and at an angle of 6°, from the X-ray source. In the middle of the beam tunnel is a helium port which allows the optic housing to be purged with helium during operation. This reduces oxidation of the mirror surfaces and eliminates air scatter.

Figure 1-2. Adjustable beam tunnel with helium port.

1.3 Osmic Confocal Optic

The Osmic confocal optic is enclosed in a brass, nickel-plated housing, as shown in Figure 1-3. The housing contains two mirrors, bonded together to form an L-shaped optic.
The input side of the optic housing mates with the spring-loaded coupling hood (Blue optic) or the adjustable beam tunnel (Green optic) using an O-ring. The optic housing is mounted to a face plate which is mounted on a translation assembly. This assembly is mounted on a wedge which places the housing at a 45° angle. The wedge is attached to a support block which also supports the collimator translation assembly.

The optic housing translation assembly has four adjustment knobs, two on the front and two on the back. The top knob, on both sides, tilts the optic housing from front to back. The front, lower knob, moves the optic housing up and down. The back, lower knob, moves the optic housing in and out of the X-ray beam.

The MSC confocal optic system is aligned during the initial site installation. A major realignment requiring movement of the optic housing should be done by an MSC service technician.
1.4 Fixed Beam Tunnel (Blue Optic)

The fixed beam tunnel is mounted using an O-ring to the output side of the optic housing, shown in Figure 1-4. This brass tunnel, set at a fixed distance from the optic housing to the collimator, provides a path for the X-ray beam. The beam tunnel is also equipped with a helium port which allows the optic housing to be purged with helium during operation. This reduces oxidation of the mirror surfaces and eliminates air scatter.

![Figure 1-4. Fixed beam tunnel (Blue optic).](image)

1.5 Fixed Beam Tunnel (Green Optic)

The fixed beam tunnel is mounted using an O-ring to the output side of the optic housing, shown in Figure 1-5. This brass tunnel provides a path for the X-ray beam, and a fixed distance from the optic housing to the collimator.

![Figure 1-5. Fixed beam tunnel (Green optic).](image)
1.6 Helium Purge Control Box

The helium purge control box, shown in Figure 1-6, is used to flush the optic housing with helium. High purity helium (99.999% helium) is used to reduce air scatter and to protect the mirrors from X-ray damage. If the optic housing is not properly purged, the mirrors will become oxidized, causing low X-ray beam intensities. **Slow Purge** is the proper setting for normal operation.

![Figure 1-6. Helium purge control box.](image)

The dial in the middle of the control box has three settings; **Flood**, **Off**, and **Slow Purge**. The flow meter on the left side of the control box corresponds to the **Flood** setting; this should be set no higher than 5. The flow meter on the right side corresponds to the **Slow Purge** setting; this should be set to 60. The **Off** and **Slow Purge** settings are used for normal operation. The **Flood** setting is only used when purging an empty optic housing. In this instance, the flow meter should still be set to 5 and the dial should be set to **Flood** for approximately ten minutes, then return to the **Slow Purge** setting to complete the gas fill.

**WARNING!**

*If the Flood flow meter is set higher than 5, the Mylar entrance window can become dislodged, causing inadequate purging.*

1.7 Collimator and Translation Assembly

The collimator, shown in Figure 1-7, has a rear aperture of 1.0 mm. The collimator slides into the fixed beam tunnel using an O-ring. (When sliding the collimator into the fixed beam tunnel, verify the collimator has passed the O-ring and is seated in the end of the fixed beam tunnel by pulling on it slightly after installation.) The output end of the standard collimator is 0.5 mm. (Optional collimators are available.)
The collimator translation assembly, shown in Figure 1-8, encompasses the fixed beam tunnel and approximately three-quarters of the collimator. The translation assembly has four micrometer adjustment knobs, two on each side and a lock-down screw at the top. The micrometer adjustments are used to adjust the height, tilt, and left and right translations of the collimator. The lock-down screw is used only if removal of the collimator is necessary. (Never move the micrometer adjustments when removing the collimator, use only the lock-down screw on top.) There is an open area for viewing the collimator while adjusting.

Figure 1-8. Collimator translation assembly (shown on Blue optic system).
NOTE:
The PIN diode should be in place while making adjustments so the intensity can be checked during the adjustment.

WARNING!
All adjustments made should be small. Even the slightest movement can cause the beam to be lost through the collimator.

1.8 Support Base

The optic system support base is made of extruded aluminum. The Osmic confocal optic and the collimator translation assembly each rest on this support base.

1.9 PIN Diode and Meter

The PIN diode assembly, shown in Figure 1-9, is an integral tool used during the alignment of the mirrors and the $\phi$-axis. The PDA-18 (PIN Diode Assembly) meter provides a visual feedback of the intensity of the beam by measuring photons leaving the mirror assembly, passing through the collimator, and hitting the PIN diode.

![PIN diode and meter diagram]

Figure 1-9. PIN diode and meter.
The PIN diode assembly consists of a magnetic base, a probe assembly with the PIN diode located in the center, and the PDA-18 meter. The probe assembly is attached to the meter box, and then to the top of the magnetic base.

The magnetic base On/Off switch is located at the bottom of the base. The base is magnetic when in the On position; moving the switch to Off will allow repositioning.

The PDA-18 meter plugs into any 110 VAC/60 Hz (or 220 VAC/50 Hz as appropriate) standard outlet. The Power switch is located in the lower left corner of the meter. For best results, verify the outlet is properly grounded. A Zero knob is located next to the Power switch. It is used to adjust the meter to zero whenever necessary. When the meter is initially turned on, it may be necessary to zero the meter before measurements may be made.

To the right of the Zero knob is a Scale knob. The range for the knob is one to six, with one being the least sensitive setting, and six being the most sensitive. (After changing scales, it may be necessary to zero the meter. Close the shutter before setting the meter to zero.)

The switch labeled 2, on the right side of the meter, is used to divide intensity by two, if necessary, to maintain a reading within the meter range rather than changing to a less sensitive scale.

### 1.10 φ–Axis

The φ-axis holds and rotates a sample during data collection. The pinhole jig and the PIN diode are used to direct the X-ray beam through the center of the φ-axis rotation.

On systems with a 2θ-stage, the φ-axis is mounted on a translational base, independent of the detector, which allows the sample to be properly positioned in the beam. The φ-axis also has a height adjustment to allow the crystal to be positioned in the beam with a variety of goniometer heads. When a sample is mounted, the only adjustment necessary is the position of the sample. When the mirrors are properly aligned, a centered sample remains in the beam continually as it is rotated.

On a non-2θ stage, the φ-axis is actually part of the area detector. The same translation, height, and angle adjustments may be made; however, each adjustment affects both the φ-axis and the detector.
## 1.11 Pinhole Jig

The pinhole jig, shown in figure 1-10, is a 0.5 mm brass tool which mounts on a goniometer head. The pinhole jig is used to align the beam through the center of the $\phi$-axis.

The $\phi$-axis is translated left and right, or up and down to position the beam through the pinhole. When this is accomplished, and a maximum intensity reading is obtained on the PIN diode meter, the optical alignment of the $\phi$-axis is complete.

## 1.12 Microscope

The microscope is used to align the sample after it is mounted on a goniometer head.

When the $\phi$-axis has been aligned, the flat side of the pinhole jig is turned toward the microscope. The translations, left and right, and height adjustments of the microscope are then used to align the crosshair on the center of the pinhole. The microscope crosshair is used to position the sample, as the crosshair indicates beam position.
1.13 Area Detector or DCU (Data Collection Unit)

The R-AXIS area detector houses two image plates (IP1 and IP2) that are used to record diffraction patterns. The information collected by the R-AXIS is converted into reflection intensity data, and used to develop molecular models.

The R-AXIS area detector may sit on a $2\theta$-stage, which is used during the alignment process to adjust the height, tilt, and angle of the detector. On an aligned system, the direct beam position will be within one pixel of the same x and y position at all crystal-to-detector distances. The difference in the y position of the direct beam at different crystal-to-detector distances will assist in setting the height and tilt of the detector, while the difference in the x position assists in setting the $2\theta$ angle of the detector along the beam path.

For area detectors without a $2\theta$-stage, the $\phi$-axis and area detector are a single unit. Adjustments made to the $\phi$-axis in front of the detector will also make changes to the area detector, and vice versa.
Chapter 2
Alignment after a Filament Change

**WARNING!**

In almost all aspects of alignment, a direct X-ray beam and scattered X-ray radiation are being produced. Take all necessary precautions to avoid exposure, such as: the shutter lamp should be clearly visible at all times, protective glasses worn (to protect the soft tissue of the eyes), leaded gloves and apron used, mounted plexiglass shields are advisable, etc. Likewise, personal dosimeters should be worn to monitor exposure. It is also recommended that a lab monitor/counter be used to detect scattered radiation when the shutter is open.

**NOTE:**

The following procedures pertain to a right port optic assembly. Differences for a left port optic assembly will be noted where applicable.

The alignment of the optic assembly must be checked after every filament change. Even though Rigaku filaments are pre-aligned, the position of the focal point should be verified after each change. After replacement, the filament is aged by slowly bringing the generator up to full power. (Refer to the generator manual for procedures to access, change and age a filament.) Place the PIN diode at the end of the collimator, as shown in Figure 2-1. Open the shutter occasionally during the aging process to see if there is a beam present. This provides an early indication of correct filament placement.

![PIN diode at end of collimator.](image)

Figure 2-1. PIN diode at end of collimator.
The optic is aligned at full power, which is 50 kV and 100 mA. Once the filament is in position and properly aged, there are five alignments to be verified before collecting data: optic alignment, area detector height/tilt alignment, ϕ-axis alignment, microscope alignment, and area detector angle alignment. When these alignments are complete, the computer software is used to update the coordinates for the center of the X-ray beam. If the coordinates are not updated, data processing will be adversely affected.

**NOTE:**

Make certain the generator bias is turned up before beginning the alignment procedure. The bias is set at 3.5 for an RU-H2R or RU-H3R generator, as shown in Figure 2-2, and to 35 for an RU-200 or RU-300, as shown in Figure 2-3.

![Figure 2-2. Bias control for RU-H2R and RU-H3R.](image1)

![Figure 2-3. Bias control for RU-200 and RU-300.](image2)

### 2.1 Osmic Confocal Optic Alignment

**WARNING!**

There is always a possibility of X-ray exposure when the shutter is open. All necessary safety precautions must be observed, such as wearing leaded gloves and safety glasses, and using a safety shield, if available.

Alignment of the Osmic confocal optic system requires the X-ray beam to travel through the spring-loaded coupling hood (Blue optic) or an adjustable beam tunnel (Green optic), the confocal optic, a fixed beam tunnel, and through the collimator using the PIN diode to achieve a maximum intensity reading for the beam. The following steps are required for this alignment.
1) Ensure the optic assembly has been purged with helium by verifying the dial setting on the helium purge control box, see Figure 1-6, is set to **Slow Purge** and the flow gauge to the right is at **60** units.

2) Ensure the image plates are in the erase position using the control program. Select **IP Positioning** and then select either **IP1** or **IP2 Erase**. It is possible to damage the plate if the direct X-ray beam strikes the IP for long periods of time.

   **NOTE:**
   
   *The shutter must be closed before placing the PIN diode at the end of the collimator.*

3) Place the PIN diode at the end of the collimator.

   **NOTE:**
   
   *For an RU-H2R or RU-H3R generator, the red light on the face of the shutter and the yellow light on the warning tower will both be illuminated when the shutter is open; on an RU-200 or RU-300 generator, the red tabletop dome light will be illuminated.*

4) **Open the shutter** by turning the three-position silver toggle switch on the front of the generator to **Open**. If the intensity reading is equal to or near the intensity reading for the previous filament, the optic alignment is complete. Proceed to Section 2.2, Detector Alignment. If the intensity reading is low, continue with step 3. If no beam intensity is picked up by the PIN diode meter, refer to Chapter 3, **Troubleshooting**, Section 3.1, **No Beam Present**.

5) Make slight adjustments to each of the four adjustment knobs on the optic housing translation assembly, Figure 2-4, while watching for a maximum intensity reading on the PIN diode. If the intensity reading on the PIN diode is equal to or near the intensity reading before the filament change, the optic alignment is complete. Proceed to Section 2.2, **Detector Alignment**. If the intensity reading is still low, continue with step 4.

---

**Figure 2-4. Optic adjustment knobs.**
6) Make slight adjustments to the collimator translation assembly, using each of the four adjustment knobs; do not use the lock-down screw on top. If a beam is present, repeat steps 3 and 4 until a maximum intensity reading is achieved on the PIN diode. If an intensity reading cannot be achieved equal to or near the reading before the filament change, contact MSC.

![Collimator micrometer adjustment knobs and lock-down screw.](image)

Figure 2-5. Collimator micrometer adjustment knobs and lock-down screw.

7) Continue with steps 5) and 6) until no higher intensity is obtained.

8) Close the shutter.

For a non-2θ-stage system, proceed with Section 2.4, Non-2θ-Stage ϕ-Axis Detector Height/Tilt and Angle Alignment.

### 2.2 2θ-Stage Detector Height/Tilt Alignment

**NOTE:**

For a detector with a non-2θ-stage, please see Section 2.4, Non-2θ-Stage ϕ-Axis, Detector Height/Tilt, and Angle Alignment.

The detector is aligned so the X-ray beam strikes the same x and y position on the image plate (IP) within one pixel, independent of the crystal-to-detector distance. This is accomplished by performing the following steps.
WARNING!
There is always a possibility of X-ray exposure when the shutter is open. All necessary safety precautions must be observed, such as wearing leaded gloves and safety glasses, and using a safety shield, if available.

Make certain the shutter is set to the External (ext) position. This will allow the computer software to control the shutter.

1) Initialize the R-AXIS system by accessing the control program and selecting Initialize. The R-AXIS will erase the IPs and place them in the proper position.

2) Verify that the shutter is closed.

3) Place a 0.006” nickel filter in front of the collimator, Figure 2-6.

4) Using the control software, take a direct beam shot with the detector all the way forward and then all the way back. (Remember to always use the same image plate.)

5) Record the x and y positions of the direct beam shot. The beam should strike the same x and y position on the image plate at both crystal-to-detector distances. (At this stage of the alignment, setting the y position, or height and tilt, is of main concern. The x position, or angle, will be discussed in Section 2.5, \(2\theta\)-Stage Area Detector Angle Alignment.)
6) If the y position of the forward and back direct beam shots are different by more than one pixel, a correction in the height of the detector must be made. The calculation used to make this correction is:

\[
\begin{align*}
\text{R-AXIS II (220 mm stage)}: & \quad (\Delta y)(63)/(\Delta d) \\
\text{R-AXIS II (450 mm stage)}: & \quad (\Delta y)(109.7)/(\Delta d) \\
\text{R-AXIS IV (300 mm stage)}: & \quad (\Delta y)(75)/(\Delta d) \\
\text{R-AXIS IV (450 mm stage)}: & \quad (\Delta y)(90)/(\Delta d)
\end{align*}
\]

where \(\Delta y\) is the difference in the y position, forward and back, and \(\Delta d\) is the difference in crystal-to-detector distances, forward and back. For example, on an R-AXIS II, 450 mm stage, a 10 pixel difference in the y position, taken at 65 and 450 mm, leads to an adjustment to the height of the detector of \((10)(109.7)/(450-65)\), or approximately 2.8 mm.

7) The height and tilt adjustments are made by turning the two feet at the back of the detector and the height adjustment nut in front, Figures 2-7 to 2-10. Both back feet must be adjusted equally. On an R-AXIS IV, one complete revolution for all three feet is equal to approximately 10 pixels. On an R-AXIS II, one turn is equal to approximately 6 pixels.

![Figure 2-7. Stage height adjustment.](image-url)
8) Repeat the direct beam shots, front and back, and adjust the height until the readings are within one pixel. (The shutter should be closed when not taking direct beam shots.)

2.3 20-Stage φ-Axis Alignment

*WARNING!*  
*It is recommended that lead-lined gloves be worn when setting the φ-axis alignment.*

*Make certain the shutter is closed to begin the alignment and the image plates are in the erase position.*
The $\phi$-axis is aligned after the height and tilt of the area detector are aligned with the X-ray beam. This alignment ensures the sample remains in the beam while being rotated and is accomplished by the following steps. (Concerning $\phi$-axis alignment of a non-2$\theta$-stage, refer to Section 2.4, **Non-2$\theta$-Stage $\phi$-Axis, Detector Height/Tilt, and Angle Alignment**.)

1) When the height and tilt of the detector are aligned, place a bubble level on the 2$\theta$-stage and mark the bubble location on the level, Figure 2-11.

![Figure 2-11. Bubble level on R-AXIS IV stage.]

2) Maintaining the same orientation, place the level on the $\phi$-axis assembly where the goniometer head will mount (see Figures 2-12 and 2-13).

![Figure 2-12. Bubble level on R-AXIS IV goniometer mount.](image)
![Figure 2-13. Bubble level on R-AXIS II goniometer mount.](image)

3) Adjust the $\phi$-plate to match the tilt of the detector stage. (See Chapter 3, **Troubleshooting**, concerning procedures to adjust the $\phi$-plate.)
4) Position the PIN diode just far enough from the collimator to allow room for the pinhole jig to be mounted.

**NOTE:**

*Ensure the pinhole jig opening is the same size as the collimator (e.g., 0.3mm or 0.5 mm).*

5) **Open the shutter** and verify the intensity reading is near the reading recorded prior to moving the PIN diode. If not, close the shutter and readjust the PIN diode. Repeat this step until the intensity is similar to the reading obtained in Section 2.1, *Osmic Confocal Optic Alignment*.

6) **Close the shutter** and mount the goniometer head with the pinhole jig in place on the \( \phi \)-assembly, Figure 2-14.

![Figure 2-14. Pinhole jig mounted.](image)

7) Visually center the flat side of the pinhole jig with the microscope, Figure 2-15.

![Figure 2-15. Pinhole jig aligned.](image)

8) Turn the round face of the pinhole jig toward the collimator.
9) **Open the shutter.**

10) If necessary, adjust the rotation and height of φ to achieve a maximum reading through the pinhole on the PIN diode meter. (See Section 3.4, φ-Plate Adjustment, concerning these procedures.)

11) Loosen the lock-down screw on the translational adjustment, or micrometer, see Figure 2-16. Translate the φ-plate left and right by rotating the micrometer to achieve a maximum reading through the pinhole.

![Figure 2-16. φ-plate translation adjustment.](image)

12) Repeat steps 10 and 11 until the intensity reading is approximately 90% of the reading prior to moving the PIN diode away from the collimator.

13) When satisfied with the intensity reading, tighten the locking clamp screw on the translational adjustment, see Figure 2-16, and confirm the φ-axis does not move.

14) After lock down, check again for changes in intensity. (If the intensity is lower, the φ-axis has moved, repeat the previous steps.)

15) **Close the shutter.**

**NOTE:**

*Do not remove the pinhole jig until the microscope alignment (Section 2.5) is complete.*

For a 2θ-stage system, continue with Section 2.5, **Microscope Alignment.**
2.4 Non-2θ-Stage $\phi$-Axis, Detector Height/Tilt, and Angle Alignment

Because the $\phi$-axis and the detector are actually one unit on a non-2θ-stage, the alignments for the $\phi$-axis, detector height/tilt, and the detector angle must all be accomplished at the same time. To perform these procedures, use the following steps:

**WARNING!**

*There is always a possibility of X-ray exposure when the shutter is open. All necessary safety precautions must be observed, such as wearing leaded gloves and safety glasses, and using a safety shield, if available.*

*Make certain the shutter is set to the External (ext) position. This will allow the computer software to control the shutter.*

1) Initialize the R-AXIS system by accessing the Control program and selecting **Initialize**. The R-AXIS will then erase the IPs and place them in the proper position.

2) Verify the shutter is closed.

3) Place a 0.006” nickel filter in front of the collimator, Figure 2-17.

![Figure 2-17. The 0.006” nickel filter in position.](image)
4) For an R-AXIS IV system, set the crystal-to-detector display box, Figure 2-18, by moving the detector to its closest position, approximately is 70 mm, with the front of the detector in contact with the $\phi$-axis. Use the number keys to enter the detector position. (For example, if setting the crystal-to-detector distance display box to 75.00, press the 4 key as many times as necessary to set the number 7, press the 3 key to set the number 5, and press the 2 and 1 keys to set the 0’s.) The numbers entered will flash on the lower portion of the display. Press the Ent (Enter) key. The numbers will stop flashing. Press the Rst (Reset) key. The top display will now read the same as the lower display. When moving the detector away from the crystal, the top display will change to reflect the crystal-to-detector distance. If the display is not functioning properly, refer to Section 3.2, Crystal-To-Detector Distance Display Box.

![Crystal-to-detector distance display box.](image)

**NOTE:**

An R-AXIS II non-$\theta$ stage will not be equipped with a crystal-to-detector display box. Use the scale on the side of the stage for the crystal to detector distance.

5) Take a direct beam shot with the detector set all the way forward and then all the way back. (Remember to always use the same image plate.)

6) Record the $x$ and $y$ positions of the direct beam shot. The beam should strike the same $x$ and $y$ position on the image plate, within one pixel, at both crystal-to-detector distances, and should also be within 10 pixels of the center of the IP. On an R-AXIS IV detector, the center of the IP is 1500; on an R-AXIS II, the center is 950.
7) If the y positions of the forward and back direct beam shots are different by more than one pixel, or are not within 10 pixels of the center of the IP, a correction in the height of the detector must be made. The calculation used to make this correction is:

R-AXIS II (220 mm stage): \((\Delta y)(63)/(\Delta d)\)
R-AXIS II (450 mm stage): \((\Delta y)(109.7)/(\Delta d)\)
R-AXIS IV (300 mm stage): \((\Delta y)(75)/(\Delta d)\)
R-AXIS IV (450 mm stage): \((\Delta y)(90)/(\Delta d)\)

where \(\Delta y\) is the difference in the y position, forward and back, and \(\Delta d\) is the difference in crystal-to-detector distances, forward and back. For example, on an R-AXIS II, 450 mm stage, a 10 pixel difference in the y position, taken at 65 and 450 mm, leads to an adjustment to the height of the back of the detector stage of \((10)(109.7)/(450-65)\), or approximately 2.8 mm. (Lowering the back of the stage will increase the y value.)

8) The height and tilt adjustments are made by turning the two feet at the back of the detector and the one foot in front, Figures 2-19 and 2-20. Both back feet must be adjusted equally. On an R-AXIS IV, one complete revolution for all three feet is equal to approximately 10 pixels. On an R-AXIS II, one turn is equal to approximately 6 pixels.

Figure 2-19. Non-2\(\theta\)-stage height adjustments.

Figure 2-20. Detail of non-2\(\theta\)-stage rear feet.

9) Repeat the direct beam shots, front and back, and adjust the height until the y value readings are within one pixel of each other and are within 10 pixels of the center of the IP. (The shutter should be closed when not taking direct beam shots.)
10) Mount the pinhole jig and PIN diode, as shown in Figure 2-14. Using the following steps, verify that the beam is going through the center of the $\phi$-axis. First, release the two lock-down screws on the front foot. Next, translate the $\phi$-axis and the detector across the beam by adjusting the pusher blocks on the front foot until a maximum intensity reading is attained on the PIN diode meter. When maximum intensity is achieved, remove the PIN diode and pin-hole jig.

**NOTE:**

*If the x and y positions are within one pixel of each other, front to back, and also within 10 pixels of the center of the IP, and maximum intensity is achieved with the pinhole jig. further adjustment is not necessary. The detector alignment is complete; continue with step 17.*

*If maximum intensity is not achieved, repeat step 10. If the x positions are not within one pixel of each other or are not within 10 pixels of the center of the IP, continue with step 11.*

11) Compare the x positions recorded in step 6. The forward x position should be close ($\pm$ 10 pixels) to the center of the IP. If the values front to back are more than one pixel in difference, or are not within 10 pixels of the center of the IP, an adjustment is necessary.

12) If the forward x position is not close ($\pm$ 10 pixels) to the center, release the two lock-down screws (if not already released) on the front foot. Using the pusher blocks, tighten one and loosen the other, moving the front of the detector as close to the center as possible, repeating forward shots as necessary.

13) When the forward position is close to the center of the IP, take a back shot and compare the x positions. If the x positions, front to back, are within one pixel of each other, and are within 10 pixels of the center of the IP, see the **NOTE** above. If the x positions are more than one pixel in difference, and are not within 10 pixels of the center of the IP, loosen the lock-down screws on the back feet. Using the pusher blocks on either side of the back feet, tighten one and loosen the other to make a slight adjustment in the detector either left or right.

14) Take a direct beam shot at the back and compare the x values.

**NOTE:**

*Because the stage and $\phi$-axis are one unit, adjusting the x position to be within one pixel in back may slightly change the front position.*
15) Take a direct beam shot in front and compare it to the x position in the back. If front and back x values are within one pixel of each other, and are within 10 pixels of the center of the IP, mount the pinhole jig and check for maximum intensity on the PIN diode. If maximum intensity is achieved, the alignment is complete, continue with step 17. If maximum intensity is not achieved, move the front and back of the detector the same amount to achieve maximum intensity, keep the angle already set as close as possible, then continue with step 16. If the x values are not within one pixel repeat from step 13.

16) Repeat from step 10 until front and back x positions are within one pixel of each other, are within 10 pixels of the center of the IP, and maximum intensity is achieved with the pinhole jig.

17) When alignment is complete (i.e., the x and y values, front to back, are within one pixel of each other, are within 10 pixels of the center of the IP, and maximum intensity is achieved with the pinhole jig) tighten the pusher blocks just until they touch and lock down the screws. Recheck the intensity readings and the x and y values to ensure the intensity remained constant during lock-down.

2.5  Microscope Alignment

**WARNING!**

*The shutter must be closed before beginning the microscope alignment.*

When the optics are focused and the $\phi$-axis is aligned to the center of the beam, verify the microscope alignment using the pinhole jig. Refer to the appropriate section for the type of microscope used.

2.5.1  R-AXIS IV Microscope

If the microscope crosshair is centered on the flat side of the pinhole jig, the microscope does not need adjustment. If the crosshair is not centered, use the following steps to center it. (An R-AXIS IV microscope is shown in Figure 2-21.)
1) Rotate the flat side of the pinhole jig toward the microscope.

2) Determine the adjustment direction to center the microscope crosshair on the pinhole jig. Adjustments available for the microscope assembly are as follows (refer to Figure 2-22): To move the microscope left and right, or up and down, loosen the thumb screw and the two lock-down screws located just below it. (Do not remove the thumb screw.) There is also a slight left and right twisting movement available when these two lock-down screws are used. Tighten one and loosen the other for this twisting action.

3) Remove the pinhole jig.

Figure 2-21. R-AXIS IV microscope.

Figure 2-22. R-AXIS IV microscope adjustments.
2.5.2 R-AXIS II Microscope

If the microscope crosshair is centered on the flat side of the pinhole jig, and both edges of the flat side of the pinhole jig align in the same position on the crosshair, then the microscope does not need adjustment. If the crosshair is not centered, or if both edges of the flat side of the pinhole do not line up in the same position on the crosshair, use the following steps: (An R-AXIS II microscope is shown in Figure 2-23.)

![R-AXIS II microscope](image)

Figure 2-23. R-AXIS II microscope.

1) Rotate the flat side of the pinhole jig toward the microscope.

2) Determine the adjustment direction to center the microscope crosshair on the pinhole jig and also to align both edges of the flat side of the pinhole jig. Adjustments available for the microscope assembly are as follows (refer to Figure 2-24): To change the angle of the microscope, loosen the top set of lock-down screws directly below the microscope. Use the push-pull screws, below the lock-down screws, to “rock” the microscope. Loosen the lock-down screws at the base of the assembly to move the assembly left and right, or forward and back.
3) Remove the pinhole jig.

### 2.6 2θ-Stage Area Detector Angle Alignment

The final aspect of the alignment for a system with a 2θ-stage, prior to updating the software, is to set the angle of the area detector to 0° by using the x positions recorded in Section 2.2, 2θ-Stage Detector Height/Tilt Alignment, for crystal-to-detector distances forward and back. Please refer to the appropriate section for the stage being used.

**NOTE:**

*If the collimator was not moved, maximum intensity is achieved, and the x values from Section 2.2, 2θ-Stage Detector Height/Tilt Alignment, step 20, are within one pixel of each other, the detector angle is correct and no further alignment is necessary. Continue with Section 2.7, Updating Software X and Y Coordinates. If the values are not within one pixel of each other, continue with the following alignment.*

### 2.6.1 R-AXIS IV 2θ-Stage

There are two types of sleds available for the R-AXIS IV 2θ-stage, steel and cast. Differences between the two sleds will be noted where applicable.
Before determining the angle alignment of the stage, it is important to verify the \( \phi \)-axis and the \( 2\theta \)-pivot are concentric. This is accomplished by performing the following the steps:

1) Release the \( \phi \)-axis so it rotates freely by turning the free-rotation lock-down screw, shown in Figure 2-25.

![Figure 2-25. \( \phi \)-axis release.](image)

2) Mount the dial indicator (see Figure 2-26) on the \( \phi \)-axis.

![Figure 2-26. Dial indicator.](image)
3) For a steel sled, sweep the needle of the indicator along the silver pivot plate on the stage (shown in Figure 2-27). For a cast sled, sweep the needle along the edge of the round silver disk in the collar on the $2\theta$-pivot (shown in Figure 2-28). (Some cast sleds have an arc ground into the stage rather than the silver disk, sweep the needle along this arc.) The dial reading must remain the same, within 0.005”, for the $\phi$-axis and the $2\theta$-pivot to be concentric.

![Figure 2-27. $2\theta$-pivot plate and adjustment points (steel sled).](image1)

![Figure 2-28. $2\theta$-pivot silver disk and adjustment points (cast sled).](image2)

4) If the dial reading changes by more than 0.005”, an adjustment in the $2\theta$-pivot will be required as described in the following steps. If the reading does not change by more than 0.005”, continue with step 10.
5) Loosen the four lock-down screws located on the top of the pivot plate. Refer to Figure 2-27 for a steel sled, Figure 2-28 for a cast sled.

6) To move the pivot plate left or right, use the pusher blocks located on the sides of the pivot plate. Refer to Figure 2-27 for a steel sled, Figure 2-28 for a cast sled. Loosen one and tighten the other until the plate is centered.

7) To move the pivot plate toward the optic assembly, loosen the pusher block closest to the optic assembly and push the detector toward the optic assembly, this allows for a coarse alignment. It may be necessary to tighten this pusher block to move the pivot plate away from the optics for final positioning.

8) When the pivot plate is positioned correctly, tighten all pusher blocks just until they touch the plate. Tighten the four lock-down screws in place on top of the plate.

9) Repeat step 3 again to ensure the plate is aligned after lock down.

10) If the x positions, forward and back, recorded in Section 2.2, 2θ-Stage Detector Height/Tilt Alignment, step 20, are not within one pixel on the IP, use the following calculation to make the correction:

\[
0.5 \arctan\left(\frac{\Delta x}{\Delta d}\right)
\]

where \(\Delta x\) is the difference in the x positions, forward and back, and \(\Delta d\) is the difference in the crystal-to-detector distance, forward and back. For example, a 10 pixel difference in the x position, taken at 100 and 450 mm, leads to an adjustment in the 2θ-angle by 0.5 \(\arctan\left(\frac{10}{450-100}\right)\), or approximately 0.082°. (Move the back of the stage to the left to lower the X value.)

11) Set the 2θ MA02 electronic display box, Figure 2-29, to 0 by pressing the * key once. While viewing the electronic display box, move the back of the detector until the display box reads the same as the number from the calculation. If the MA02 electronic display box is not working properly, refer to Section 3.5, MA02 Electronic Display Box.
12) Repeat the forward and back direct beam shots. If, after entering the x values into the formula, the x value is off by a factor of 2, the detector was moved in the wrong direction. Move the detector the opposite direction until the display box shows the opposite reading.

13) When the detector is aligned, take a front and back direct beam shot. If the x values are within one pixel, the angle of the detector is correct. If the x values are not within one pixel, repeat steps 10 through 13.

When the angle of the detector is correct, the electronic display is set to 0° to reflect the 0° point for the detector. Set the 0 point on the display by performing the following steps:

14) Using the micrometer adjustment, Figure 2-30, below the pivot plate, move the sensor until the wedge piece, Figure 2-31, on the pivot plate breaks the plane in the sensor, causing the red light on the back of the sensor to turn Off.
15) When the red light on the sensor is **Off**, reset the electronic display box by pushing the *button. The display will be reset to 0. If the electronic display box is not working properly, refer to Section 3.5, *MA02 Electronic Display Box*.

When the detector is set to true $2\theta = 0^\circ$, it may be moved to a specific angle for collecting higher resolution data.

The final step is to program the crystal-to-detector distance display box by performing the following steps:

16) Determine the correct crystal-to-detector distance by recording the x position for each of the following three direct beam shots:

<table>
<thead>
<tr>
<th>Distance (mm)</th>
<th>$2\theta$ (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>200</td>
<td>10</td>
</tr>
</tbody>
</table>

Use the following formula to determine the crystal-to-detector distance at the closer measurement:

$$XTD = \frac{D_1 - D_2}{\left(\frac{X_3 - X_2}{X_3 - X_1}\right)}$$

where $D_1$ and $D_2$ are the crystal-to-detector distances, and $X_1$, $X_2$, and $X_3$ are the x pixel values recorded at the two crystal-to-detector distances using the three different $2\theta$ angle settings.
17) Move the detector to the closest camera position. Using the number keys on the crystal-to-detector distance display box, Figure 2-32, enter the closest camera position as determined in step 16. (For example, if setting the display box to 75.00, press the 4 key as many times as necessary to set the number 7, press the 3 key to set the number 5, and press the 2 and 1 keys to set the 0's.)

![Figure 2-32. Crystal-to-detector distance display box.](image)

18) The numbers entered will be flashing on the lower portion of the display.

19) Press the Ent (Enter) key. The numbers will stop flashing.

20) Press the Rst (Reset) key. The top display will now read the same as the lower display. When moving the detector away from the crystal, the top display will change to reflect the crystal-to-detector distance. If the display is not functioning properly, refer to Section 3.4, Crystal-to-Detector Distance Display Box.

2.6.2 R-AXIS II $\theta$-Stage

Before determining the angle alignment of the stage, it is important to verify the $\phi$-axis and the $2\theta$-pivot are concentric. This is accomplished by performing the following steps:

1) Release the $\phi$-axis so it rotates freely by turning the free-rotation lock-down screw, shown in Figure 2-33.
2) Mount the dial indicator (see Figure 2-34) on the φ-axis.

3) Sweep the needle of the indicator along the edge of the pivot plate on the stage, Figure 2-35. The dial reading must remain the same, within 0.005", for the φ-axis and the 2θ-pivot to be concentric.
4) If the dial reading changes by more than 0.005", an adjustment in the 2θ-pivot will be required as described in the following steps. If the reading does not change by more than 0.005", continue with step 10.

5) Loosen the four lock-down screws, Figure 2-35, located on the top of the pivot plate.

6) To move the pivot plate left or right, use the pusher blocks, Figure 2-35, located on the sides of the pivot plate. Loosen one and tighten the other until the plate is centered.

7) To move the pivot plate toward, or away from the optic assembly, use the pusher blocks in the front and rear of the pivot plate. Loosen one and tighten the other until the plate is centered.

8) When the pivot plate is positioned correctly, tighten all pusher blocks just until they touch the plate. Tighten the four lock-down screws in place on top of the plate.

9) Repeat step 3 again to ensure the plate is aligned after lock down.

When the φ-axis and the 2θ-pivot are concentric, the 2θ-angle of the detector is set to 0° by performing the following steps:

10) If the x positions, forward and back, recorded in Section 2.2, 2θ-Stage Detector Height/Tilt Alignment, step 20, are not within one pixel on the IP, use the following calculation to make the correction:

\[
0.5 \arctan[(\Delta x)(0.1017)/\Delta d)]
\]
where $\Delta x$ is the difference in the x positions, forward and back, and $\Delta d$ is the difference in the crystal-to-detector distance, forward and back. For example, a 10 pixel difference in the x position, taken at 65 and 450 mm, leads to an adjustment in the $2\theta$-angle by $0.5 \arctan[(10)(0.1017)/(450-65)]$, or approximately $0.076^\circ$. (Move the back of the stage to the left to lower the X value.)

11) Set the $2\theta$ RSF Z525 Electronics (also called DRO) display box, Figure 2-36, Y axis to 0 by pressing the Y Axis button. This will set the Y axis value to 0.

![Figure 2-36. 2θ RSF Z525 Electronics display box.](image)

12) While viewing the Y axis value on the display box, move the detector the required amount as determined by the calculation in step 10. Reset the DRO display to 0 again by pressing the Y Axis button.

13) When the detector is aligned, take a front and back direct beam shot. If the x values are within one pixel the angle of the detector is correct. If the x values are not within one pixel, repeat steps 10 through 13.

When the detector is set to true $2\theta = 0^\circ$, it may be moved to a specific angle for collecting higher resolution data.

The final step is to program the actual crystal-to-detector distance by performing the following steps:

14) Determine the correct crystal-to-detector distance by recording the x position for each of the following three direct beam shots:

- 100 mm, $\theta = 0^\circ$
- 100 mm, $\theta = 10^\circ$
- 200 mm, $\theta = 10^\circ$
Use the following formula to determine the crystal-to-detector distance at the closer measurement:

\[ X_{TD} = \frac{D_1 - D_2}{\left( \frac{X_3 - X_1}{X_2 - X_1} \right)} \]

Where D1 and D2 are the crystal-to-detector distances, and X1, X2, and X3 are the x pixel values recorded at the two crystal-to-detector distances using the three different 2θ angle settings.

15) Move the detector to the closest camera position.

16) Press the Preset key, which is to the right of the X axis display window. This will blank out the display.

17) Using the numeric keypad, enter the number determined from the formula in step 14 for the closest camera position. This automatically loads the number entered into the X axis display.

18) If the display is not functioning properly, refer to Section 3.6, RSF Z525 Electronics (DRO) Display Box.

2.7 Updating Software X and Y Coordinates

In order to process data correctly, the SYSTEM.TXT file must be updated to record the coordinates for the center of the beam. Refer to the appropriate section for the computer being used.

2.7.1 SGI Computer

1) Access the R-AXIS Control program.

2) Select the Adjust Menu.

3) From the Adjust Menu, select the Direct Beam Intensity Check.

**NOTE:**

*On an R-AXIS II detector, step 4 is not necessary. Proceed to step 5. The R-AXIS II automatically runs one cycle to update the coordinates. The R-AXIS IV requires 10 cycles, due to an offset between IP1 and IP2, to update coordinates.*

4) Where asked, select 10 Cycles.
5) Move the detector to the desired distance for data collection.

6) Move the shutter switch on the generator to the Ext position.

7) Select Go. The program will perform 10 cycles of direct beam shots and update the SYSTEM.TXT file automatically for the R-AXIS IV. For an R-AXIS II, the software will only perform one cycle of direct beam shots.

8) The system is now ready to collect data.

2.7.2 VAX Computer (R-AXIS II Only)

1) Exit the control program.

2) At the prompt, type ADJUST. Press Enter.

3) From the Adjust menu, select Direct Beam Intensity Check.

4) Follow the prompts to perform the direct beam intensity check.

5) Move the detector to the desired distance for data collection.

6) Move the shutter switch on the generator to the Ext position.

7) Select Go. The program will perform one cycle of direct beam shots for an R-AXIS II.

8) Record these values for future use in setting up data collection parameters.

9) The system is now ready to collect data.
Chapter 3
Troubleshooting

3.1 No Beam Present

If no beam is present, or there is no intensity reading on the PIN diode meter, use the following steps:

1) Verify the PIN diode is plugged in and all cables are attached.

2) Verify the PIN diode is positioned properly at the end of the collimator, refer to Figure 3-1.

3) Verify the X-rays are turned on and at full power; 50 kV, 100 mA.

4) Verify the bias for the generator is set to 3.5 for an RU-H2R or RU-H3R, or to 35 for an RU-200 or RU-300.

5) Verify the shutter is opening; the shutter bulb should illuminate.

6) Verify the PIN diode is functioning properly by performing one, or both, of the following steps. If after performing these steps there is no beam present, proceed with step 7).

   a) Position a rate meter at the end of the collimator and open the shutter. If the meter registers a radiation reading, then there is a beam present and the PIN diode is at fault.
b) Place the 0.006” nickel filter at the end of the collimator and perform a direct beam shot. If the detector is showing a spot on the image plate, there is a beam present and the PIN diode is at fault.

**WARNING!**

*Verify the shutter is closed.*

7) Loosen the collimator lock-down screw located at the top of the collimator translation assembly, refer to Figure 3-2, and remove the collimator.

![Collimator lock-down screw](image)

Figure 3-2. Collimator lock-down screw.

**WARNING!**

*DO NOT make adjustments to the four micrometer adjustment knobs as the beam may be lost through the collimator with even the slightest movement.*

8) Insert the alignment tube with phosphor, Figure 3-3, and tighten the lock-down screw.
9) **Open the shutter** and adjust the micrometer adjustment knobs until the beam is located on the center of the crosshair on the alignment tube. If no beam can be located, contact MSC. If the beam is located, proceed with step 9).

10) When the beam has been found and centered on the crosshair, **close the shutter** and remove the alignment tube using the lock-down knob only.

11) Re-install the largest collimator available and **open the shutter**.

12) If no beam is present, **close the shutter**. Using the lock-down screw, remove the collimator and take out the rear aperture, refer to Figures 3-4 and 3-5.

13) Re-install the collimator and **open the shutter**. Adjust the collimator using the four micrometer adjustment knobs until a maximum intensity is achieved on the PIN diode.
14) Once the beam is located, **close the shutter** and remove the collimator and replace the rear aperture and repeat step 12.

15) **Close the shutter** and replace the collimator with the next size smaller. Make necessary adjustment to the four micrometer adjustment knobs until a maximum intensity is achieved on the PIN diode.

16) Repeat step 14 until using the smallest size collimator available.

17) When this procedure is complete, continue with Section 2.1, **Confocal Optic Alignment**.

### 3.2 Low Intensity Readings

The best indication of an alignment problem in the system is a drop in the intensity reading on the PIN diode meter. For this reason, it is a good idea to record the intensity reading after each optic alignment. This record will indicate when the intensity has dropped.

Very little manipulation of the optic should be necessary to achieve the same intensity on the PIN diode meter if all procedures are performed correctly during the filament change.

If the previous filament was working properly, and the intensity has dropped after changing the filament, the last few frames of data from the previous filament can be viewed to determine the problem. If the PIN diode intensity reading is the same and a direct beam shot is done, compare the numbers from the detector for the direct beam shots performed before the filament change and after. Lower numbers in the current frames indicate a problem with the detector.

If the intensity reading is lower on the PIN diode meter, the following steps will help to locate the problem:

1) Check the helium flow to the optic housing. The dial setting should be set to **Slow Purge** and the flow meter to the right should be at 60 units.

2) Check the bias setting, refer to Figures 3-6 and 3-7. On an RU-H2R or RU-H3R generator, the bias should be set to 3.5, on an RU-200 or RU-300, it should be set to 35. Bias is very important in an alignment, as it actually correlates to better focus of the beam coming off the filament. To ensure the bias is working properly:
**WARNING!**

*NEVER set the bias higher than 3.5, with a .3 focus as this could cause anode damage.*

---

a) Watch the filament current meter on the generator. As the bias is turned up, there will be a slight movement in the needle. No movement in the filament current meter indicates the bias is not working.

---

**WARNING!**

*There is always a possibility of X-ray exposure when the shutter is open. All necessary safety precautions must be observed, such as wearing leaded gloves, safety glasses, and using a safety shield, if available.*

---

b) Place the PIN diode at the end of the collimator and **open the shutter**. Adjust the PIN diode so the reading on the meter is near the center. Turn the bias up. If the bias is working, there will be an obvious change in the intensity on the PIN diode meter.

If the bias is not working:

a) Shut down the generator, leaving only the water system on, and let the cathode cool for approximately one hour.

b) Pull out the cathode assembly. (See the Generator manual for instructions.)
c) With an ohm meter, check for a filament short in the cathode housing. Set a volt/ohm meter to **Ohm**; touch the red and black leads together to see a short on the ohm meter. Then, place one lead at the point where the filament wire screws into the filament lead, place the other lead anywhere on the cathode housing. If the meter reads the same as it did when the leads were touched together, the filament has a short.

To correct this problem, position the filament correctly in the cathode. As a general rule, at every filament change, when the filament is placed into the cathode, it should be checked for a short.

**WARNING!**

*In step d) below, the solution for the bias not working calls for removing the cathode while it is hot to check for a short. Use extreme caution when handling the cathode in this manner. Always wear insulated gloves. It is also possible to strip the screws; use extreme caution while removing them.*

d) When the filament has been aged and brought up to full power, it also becomes hot. If the filament is set close to a screw, as it heats and expands, it is possible it will touch the screw, causing a short. To verify that this is the problem, shut the generator down, release the vacuum, and using **insulated gloves**, immediately (while it is hot) pull the cathode out of the system and check for a short.

If the bias is working:

a) It is possible the bias circuit in the generator is not working. If this could be the case, contact an MSC service technician.

3) It is necessary to inspect the anode at every filament change and polish it at every other filament change. A dirty anode, or a groove in the anode, can cause a 20 to 30% drop in intensity. The anode may be cleaned with a Scotch-Brite pad. However, if a groove cannot be polished away, return the anode to MSC for evaluation. (A groove in the anode broadens the focal spot.)

### 3.3 φ-Plate Adjustment

The φ-plate is mounted on three vertical posts, or legs. For each leg, there is a set of push-pull screws for adjustment. For height adjustment, all three sets of push-pull screws will be used. After the initial on-site installation, the only adjustment that may be necessary is the front to back tilt. When adjusting the tilt, one set of push-pull screws will be used, depending on the direction of φ-plate tilt required. For these procedures, use the following steps:
1) Place a bubble level on the 2θ-stage and mark the bubble location on the level.

2) Maintaining the same orientation on the level, place the level on the φ-axis assembly.

3) With the level placed on the φ-axis, adjust only the push-pull screws on the leg closest to the optics. Make small adjustments on the screws until the bubble is lined up as it was on the stage.

4) When the adjustment is complete, lock down both screws making sure that the bubble remains in the same position.

3.4 Crystal-to-Detector Distance Display Box

The crystal-to-detector distance display box, Figure 3-8, is used with an R-AXIS IV system using either a 2θ-stage or a non-2θ-stage, to show the correct distance from the sample to the detector. If the top display is not changing when moving the detector away from the crystal, check the following:

1) Verify the CN1 cable running to the top of the box is plugged in properly.

2) Verify the green light (STB/ALM) on the sensor indicator is **On**.

3) Verify the red LED reflected light is visible on the metal read-out strip, located on the stage. If this light is out, the sensor is bad.

Figure 3-8. Crystal-to-detector distance display box.
NOTE:
The sensor is mounted on the stage and can be found by tracing the CNI cable to the stage.

If problems still occur with the display box, it is possible the original DIP switch settings have been changed.

1) The correct DIP settings are: all small SW switches 1 through 10 should be set to Off, with the exception of SW 5.

After checking the DIP switches, correct the programming as follows:

1) Press the Fun key. The display shows F- on the panel.

2) Press the 2 key (numerical). The current mode is now F-2.

3) Press the 1 key from the digit keys (1 to 5) at the bottom. Set the indicating value as 0.1. Press the Ent (Enter) key. This indicates one pulse corresponds to 0.1 mm.

4) Press the Fun key, and set the bottom display to 70.0 by using the digit keys 2 and 3.

5) Press the Ent key, the aimed value of 70.0 is now confirmed.

6) Press the Rst key, 70.0 is now confirmed in the top display.

7) Move the detector toward the crystal fully. The mechanical stop point is 70 mm. Press the Rst key again, the top display value will show 70 mm.

3.5 MA02 Electronic Display Box

The MA02 electronic display box, Figure 3-9, is used with an R-AXIS IV system using a 2θ-stage, to show the correct 2θ angle. If the display box begins to blink or read incorrectly, use the following steps to correct the problem.
1) Verify the display box is plugged into a standard outlet, not into the generator.

2) Check the display box programming using Table 3-1.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Display</th>
<th>Programmed Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td><em>rES</em></td>
<td>FREE</td>
</tr>
<tr>
<td>Factor</td>
<td><em>FAC</em></td>
<td>.350</td>
</tr>
<tr>
<td>Reference value</td>
<td><em>rEF</em></td>
<td>0000.00</td>
</tr>
<tr>
<td>Offset value</td>
<td><em>oFF</em></td>
<td>OFF</td>
</tr>
<tr>
<td>Decimal point</td>
<td><em>dP</em></td>
<td>0.00</td>
</tr>
<tr>
<td>Counting direction</td>
<td><em>dir</em></td>
<td>UP</td>
</tr>
<tr>
<td>Type of reference switch</td>
<td><em>trS</em></td>
<td>N.O.</td>
</tr>
<tr>
<td>Store value</td>
<td><em>Sto</em></td>
<td>ON</td>
</tr>
<tr>
<td>Access: absolute reset</td>
<td>_F_Abs</td>
<td>ON</td>
</tr>
<tr>
<td>Access: relative reset</td>
<td><em>F_rEL</em></td>
<td>OFF</td>
</tr>
<tr>
<td>Access: reference value</td>
<td><em>F_rEF</em></td>
<td>OFF</td>
</tr>
<tr>
<td>Access: offset value</td>
<td><em>F_oFF</em></td>
<td>OFF</td>
</tr>
<tr>
<td>Language</td>
<td><em>LAn</em></td>
<td>E</td>
</tr>
</tbody>
</table>

Table 3-1. MA02 Programming.

3) Verify the gap for the sensor strip is set correctly, according to Figure 3-10, and the index mark is horizontal to the sensor strip.
Error messages and the corrective action required are listed in Table 3-2.

<table>
<thead>
<tr>
<th>Message</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full</td>
<td>display overrun</td>
<td>- check parameters and adjust them if necessary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- set display to reference value</td>
</tr>
<tr>
<td>Display blinking</td>
<td>faulty/no sensor signal</td>
<td>- check gap between sensor and magnetic strip</td>
</tr>
<tr>
<td>Display blinking</td>
<td>device has been switched On with storage <em>Sto</em> = “OFF”</td>
<td>- set display to reference value</td>
</tr>
</tbody>
</table>

Table 3-2. MA02 Error messages.
### 3.5 RSF Z525 Electronics (DRO) Display Box

The RSF Z525 Electronics (DRO) display box, Figure 3-11, is used with an R-AXIS II system using a 2θ-stage, to show the correct crystal-to-detector distance and 2θ angle. When the power is initially turned on, the display(s) will flash all 8’s until either the X Axis or Y Axis key is pressed. The X Axis key corresponds to the crystal-to-detector distance, and the Y Axis key corresponds to the 2θ angle.

![RSF Z525 electronics (DRO) display box.](image)

Zero the display by performing the following steps:

1) Press the X Axis key to automatically reset the X axis display to 0.

2) Press the Y axis key to automatically reset the Y axis display to 0.

Preset a number in the display by using the following steps:

1) Press the Preset key, which is to the right of the X axis display window, to blank out the display. The number to be preset may now be keyed in using the numeric key pad. After entering the number, press the Enter key. This automatically loads (in the X axis display) the number entered.

2) Repeat step 1 for the Y axis.

Operation of the incremental/absolute (Inc/Abs) feature is described in the following steps:

1) Verify the red LED, above the Inc/Abs key, is not lit. If it is on, press the key once and the light will turn off.
2) Press the **X Axis** and the **Y Axis** keys. Both of the **Absolute** mode display registers are now reset to 0.

3) Press the **Inc/Abs** key to switch to the **Incremental** mode. The red LED will be lit.

4) The display can be used for normal operation with the display at zero or numbers preset.

Operation of the (MM/Inch) feature is described in the following steps:

1) The digital readout is a microprocessor based unit, therefore, it has true MM/Inch conversion.

2) Press the **MM/Inch** key to toggle the display from either **MM** to **Inch** or **Inch** to **MM**. The red LED will be on in the **MM** mode.
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