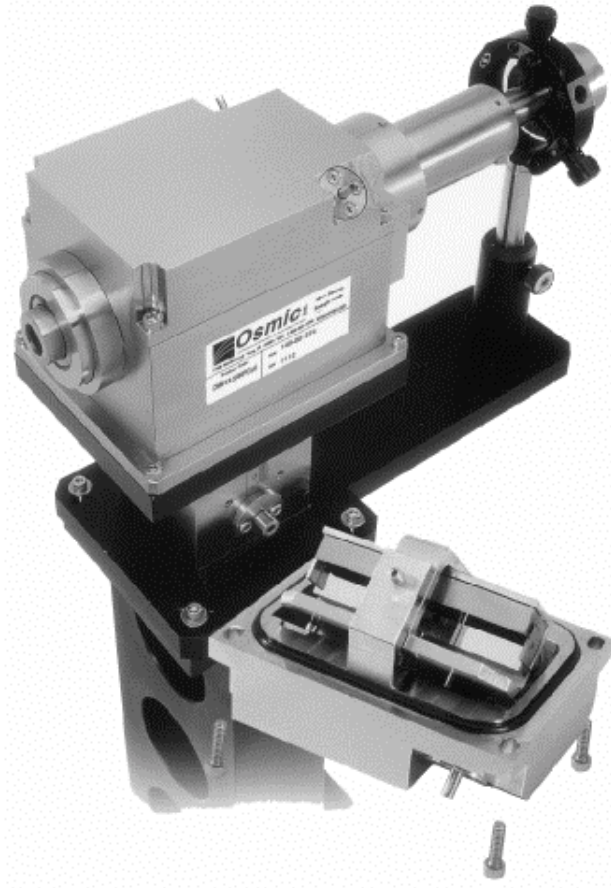


# Confocal Max-Flux Optics™

## User Manual

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## Welcome

Thank you for purchasing the Confocal Max-Flux™ (CMF) beam conditioning optics developed by Osmic, Inc. The system provides a monochromatic hard x-ray beam, either focused or collimated, by combining a “side-by-side” approach to the Kirkpatrick-Baez scheme with high performance multilayers. Precision optical construction and superior graded multilayer coatings yield the best optics for high intensity and low background. Additionally, the compact and well-designed assembly provides easy installation, alignment and maintenance.

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## **Safety**

### X-ray Equipment and CMF Optics

X-ray equipment produces potentially harmful radiation and can be dangerous to anyone in the immediate vicinity unless safety precautions are completely understood and implemented.

All persons designated to operate or perform maintenance should be fully trained on the nature of radiation, x-ray generating equipment and radiation safety.

All users of the x-ray equipment should be required to accurately monitor x-ray exposure by proper use of x-ray dosimeters.

For safety issues related to the operation and maintenance of your particular x-ray generator, diffractometer and shield enclosure, please refer to the manufacturer operation manuals or your Radiation Protection Supervisor. The user is responsible for compliance with local safety regulations.

Osmic assumes no responsibility for accidental exposure due to improper operation of existing equipment or the improper installation of CMF optics.

### Hazardous Materials

Most CMF optic assemblies contain beryllium windows (see assembly drawing for locations). Beryllium is potentially hazardous if ingested, inhaled or absorbed through the skin. Care should be taken to avoid contact with the CMF x-ray windows. Beryllium must never be drilled, ground or sanded except by qualified individuals using appropriate respiratory equipment and dust containment and collection apparatus.

## Warranty

### **OSMIC, INC. - LIMITED WARRANTY AND LIMITATION OF LIABILITY**

Except to the extent as otherwise provided herein, for one year after either shipment to the Buyer or, when appropriate, installation of the product by Osmic, Inc. ("Osmic"), Osmic warrants each new product manufactured and sold by Osmic, or one of its authorized dealers, only against defects in workmanship and/or materials under normal service and use. Products which have been changed or altered in any manner from their original design, or which are improperly or defectively installed, serviced or used are not covered by this warranty.

**THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED INCLUDING WARRANTIES AGAINST INFRINGEMENT, MERCHANTABILITY, AND/OR FITNESS FOR A PARTICULAR PURPOSE.**

Osmic's obligations with respect to this warranty are limited to the repair or replacement of defective parts after Osmic's inspection and verification of such defects. All products to be considered for repair or replacement are to be returned to Osmic after receiving authorization from Osmic. Except as stated herein, the Buyer assumes all risk and liability whatsoever resulting from the use of said product. **In no event shall Osmic be liable to the Buyer for any indirect, special or consequential damages for lost profits, even if Osmic has been advised of the possibility thereof, and regardless of whether such products are used singularly or as components in other products.**

The provisions of this Limited Warranty and Limitation of Liability may not be modified in any respect except in writing signed by a duly-authorized officer of Osmic.

When printed on or attached to any document issued by Osmic, or any of its authorized dealers, this Warranty contains the complete and exclusive statement of Osmic's obligations with respect to any of its products.

## Introduction

### Operating Principles

Utilizing constructive interference as in Bragg Diffraction (Figure 1), thin film multilayers reflect x-rays at larger angles than total reflection mirrors, yielding a larger capture angle and thus larger flux. In addition, while a total reflection mirror passes all energy below its cut-off energy (relying on filters to remove unwanted spectra), a multilayer reflector is a natural band-pass filter, automatically monochromatizing the beam thereby providing more intensity with much lower background. Another commonly used optical system, graphite monochromators, are also Bragg reflectors. However, while graphite provides a very monochromatic beam, it is divergent and delivers no intensity gain.

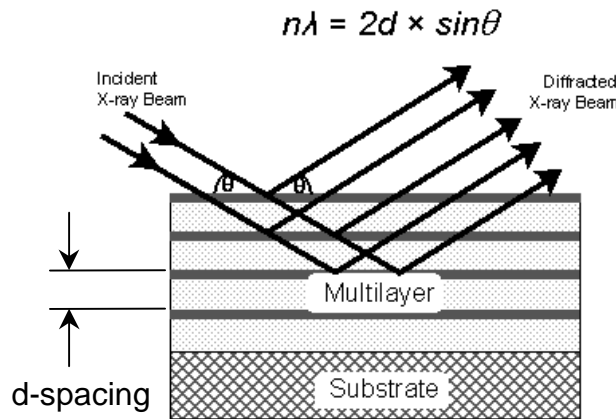


Figure 1. Multilayer working principle

Collimating and focusing mirrors are realized by curving the mirror surfaces into either parabolic or elliptical shapes. The d-spacing (thickness of a single bilayer) of the multilayer coating is controlled along the mirror surface to satisfy Bragg's law at every point (Figure 2). The band-pass of a multilayer optical system can be further controlled by using different materials and layer configurations for different applications.

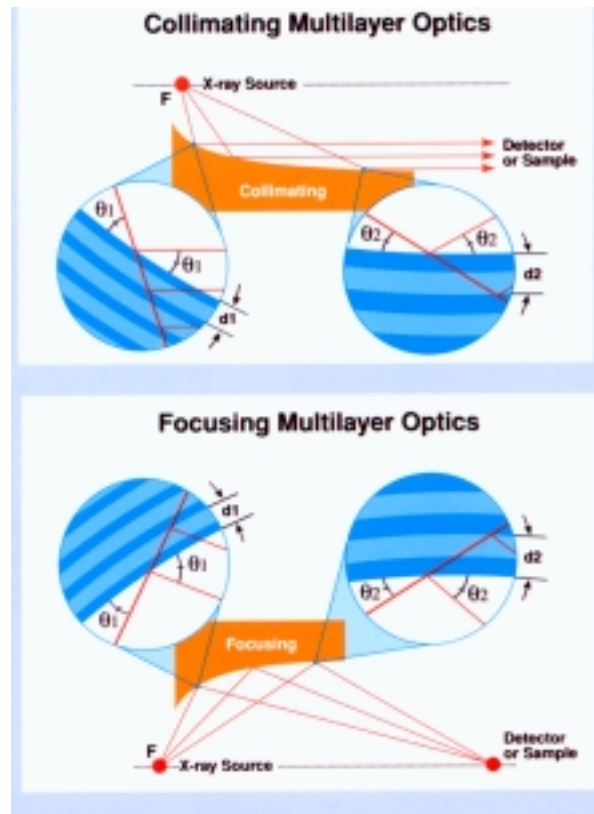


Figure 2. Graded d-spacing multilayer

A two-dimensional reflection system is realized by using two mirrors in a "side-by-side" Kirkpatrick-Baez scheme (Figure 3). Each mirror independently reflects x-rays in one of the two perpendicular directions. With the "side-by-side" scheme, both mirrors of a Confocal Max-Flux™ optic may be positioned at an position appropriate to optimize performance parameters including flux, spectrum and divergence.

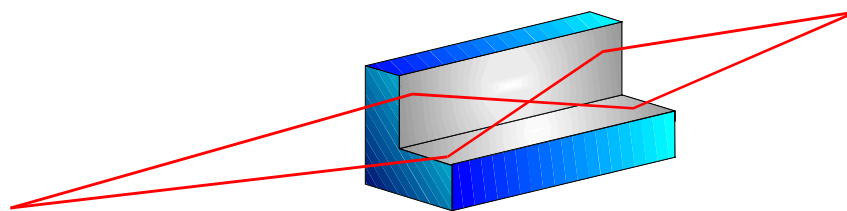


Figure 3. A Confocal Max-Flux™ Optic

Typical applications of CMF optics include protein crystallography, small angle x-ray scattering and thin film/stress analysis. Custom optics may also be designed for a specific application (contact Osmic Inc. for details). The x-ray source may either be a laboratory source or a synchrotron and the output beam either collimated or focusing, including microfocusing.



### System Overview

In general, the typical CMF system assembly consists of five segments: anode adapter, incident beam pipes, mirror housing, output beam pipes and alignment tower. Figure 4 is a schematic drawing of a generic CMF system. For your specific system, refer to the assembly drawing and parts list provided separately.

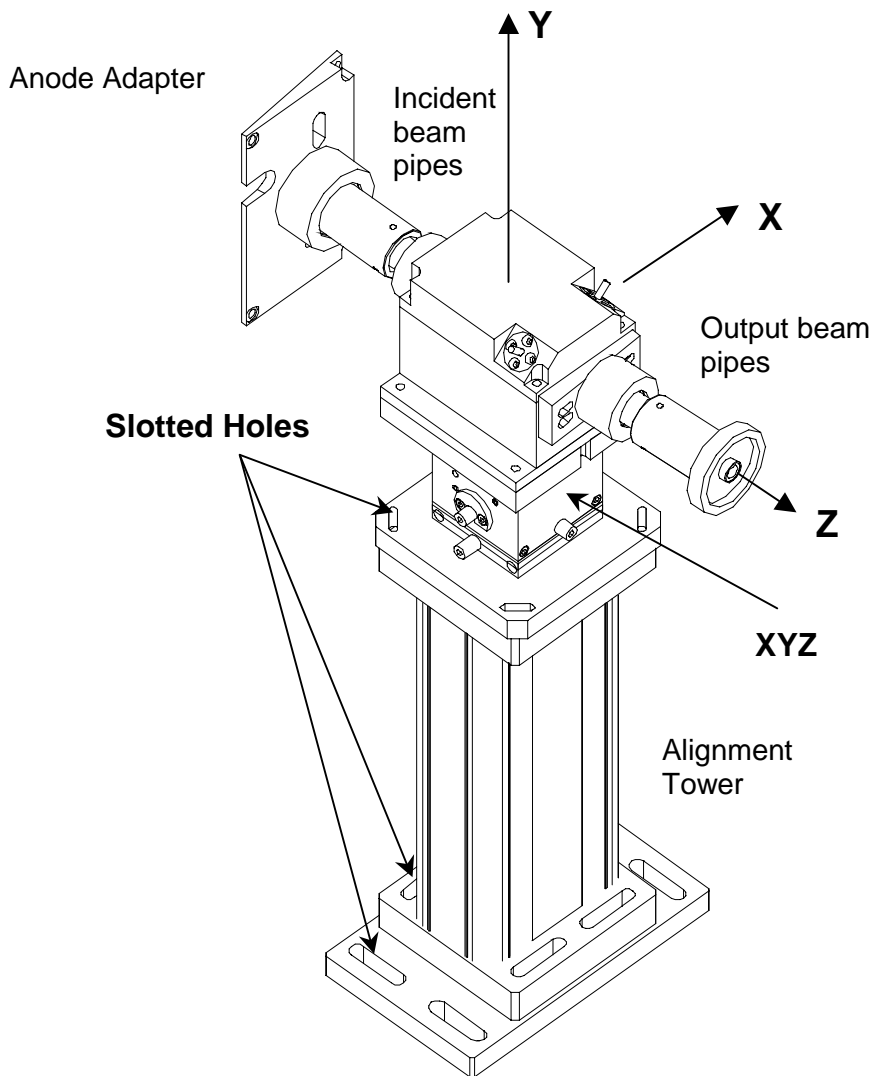


Figure 4. Typical CMF assembly

## Anode Adapter and Beam Pipes

The anode adapter plate connects to specific generator models (e.g. Rigaku, Siemens, etc.) and provides shielding from x-ray leakage, safety switch/shutter actuation and interfacing to the incident beam pipes. Beam pipe assemblies for both incident and output sides of the mirror housing are generally made out of two or more telescoping parts. The connections are sealed by internal o-rings in order to maintain an air-tight seal for either helium purge or vacuum and are adjustable in length (excluding CMF systems with short source-to-optic distance). The beam pipes are also shielded by metal shielding rings at connection joints and may have hose barb fittings for gas or vacuum connections. Two Beryllium (Be) windows are used at the entrance and exit of the optical system, maximizing the beam path in the purged environment.

On the output side of the mirror housing, depending on the specific diffractometer setup, a pinhole pipe or an appropriate interface to the original system is provided.

## Mirror Housing and Angular Adjustment

Two multilayer reflectors are pre-aligned at 90 degrees and mounted in a double cradle as shown in Figure 5. The cradle is mounted in the lid of the mirror housing by two pivoting screws. The cradle has two independent rotational degrees of freedom about the center of each reflector. Precision alignment screws mounted on the housing lid realize the angular alignment of each reflector. Turning the left adjustment screw clockwise and the right adjustment screw counterclockwise will increase the incident angle of the upper and lower reflector, respectively. Square apertures (1.5mm) are located at each end of the CMF optic to block the direct x-ray beam (see Figure 5,6).

**NOTE: THE MIRROR HOUSING CONTAINS NO USER SERVICABLE PARTS.**

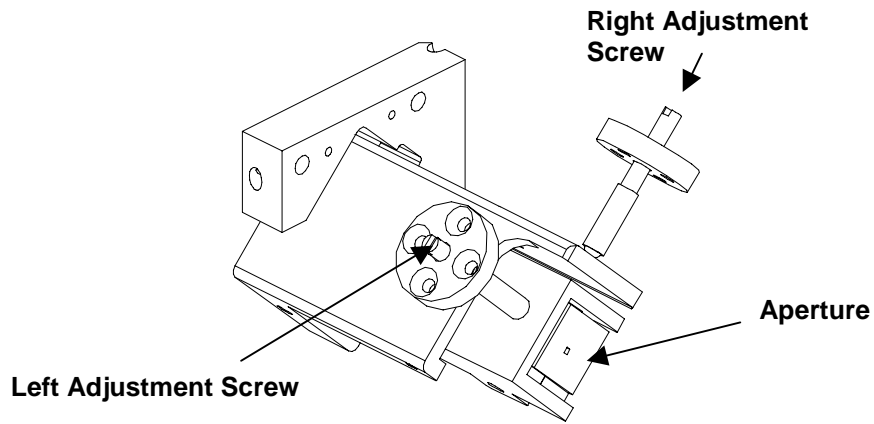


Figure 5. Angular alignment

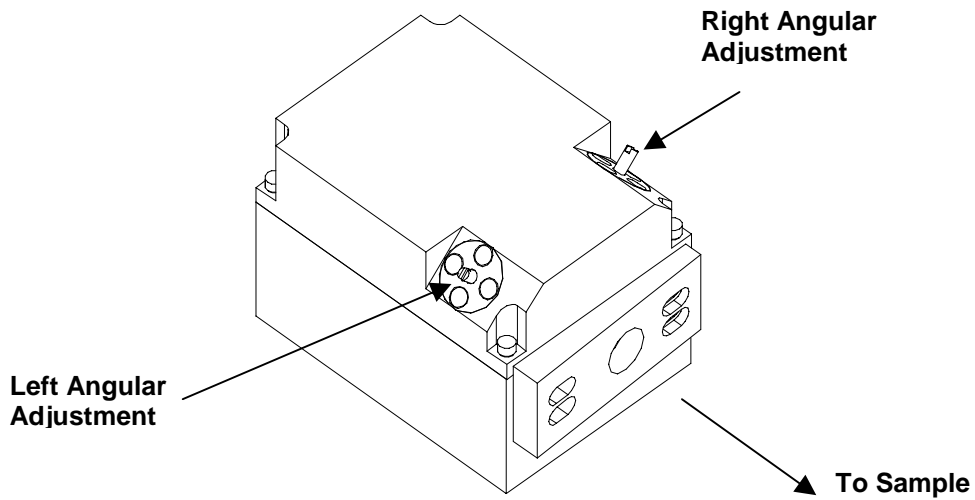


Figure 6 Mirror Housing

### Alignment Tower

The alignment tower is composed of a pedestal assembly and an XYZ stage, as shown in Figure 7. The slots on the base plates allow rough translational adjustments in two directions. The curved slots of the top plate allow rotation of the mirror housing  $\pm 6$  degrees to meet the take-off angle requirement of the source. The XYZ stage provides the precision adjustment of the optic position along the beam line, across the beam line (which changes the take-off angle) and the mirror height.

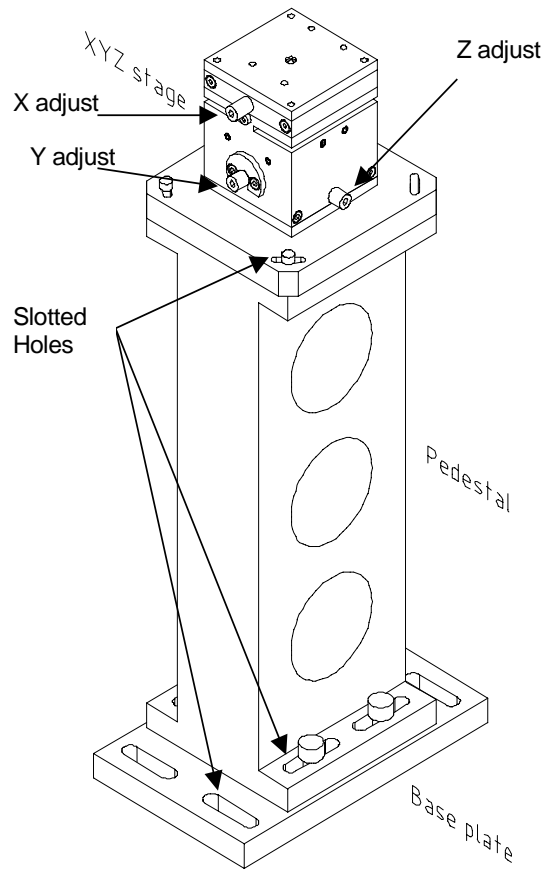


Figure 7. Alignment tower

## Installation

The Confocal Max-Flux™ Optical system should be positioned relative to the source for correct take-off angle and an accurate Bragg angle. The following procedure is for first time installation only.



**WARNING:** Shut down the x-ray generator before removing the old optical system and installing the CMF optical system. **Do not proceed beyond this point until you have read the Safety section of this manual.**

Installation

### Install Hardware

#### 1 Install the anode adapter

The anode adapter is mounted to the generator housing with the same mounting holes used for the shutter assembly. Remove shutter cover plate and replace with the anode adapter. Make sure that the shutter moves freely after installation.

#### 2 Assemble the optical hardware

Assemble and finger tighten all parts indicated in the assembly drawing. Adjust the vertical stage to make sure that the center height of the mirror housing window is the same as the beam height.

#### 3 Install the assembly onto generator tabletop.

Connect the incident beam pipes to the anode adapter. Arrange the assembly relative to the x-ray source such that the take-off angle is between 3 and 6 degrees. This is accomplished by adjusting the assembly until the incident beam pipes are visually perpendicular to the anode adapter. Position the pedestal so that the distance between the source and the center of the mirror housing is correct for your optic (see source-mirror distance on specification sheet provided separately). For some systems, this may require telescoping the beam pipe assembly and/or compressing spring-loaded rings. Adjust the

mirror housing rotationally to position the mirror housing parallel to the beam line.

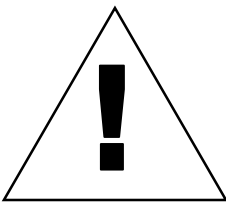
**4 Place all slots nominal**

Make sure all slotted hole connections (the base plate, the horizontal alignment stages, both along the beam line and perpendicular to the beam line) are centered. Drill and tap 4 mounting holes (if necessary) for your particular system using the template provided separately. Mount the base plate firmly on the appropriate surface (eg. rotating anode tabletop, tooling table etc.).

Installation

**5 Connect for helium purge or vacuum**

Use the 0.25" hose connectors provided (typically on the mirror housing and/or the beampipes) to connect to either a helium purge system or vacuum pump. Operating settings for helium flow is recommended at 1cc/sec and < 1 torr for vacuum.

	<p><b>WARNING:</b> Continuous extended exposure of the multilayer optic to intense radiation <u>in air</u> may degrade performance. Do not operate the CMF system without either a helium purge or vacuum after installation and alignment is complete.</p> <p><b>FAILURE TO FOLLOW THIS PROCEDURE MAY VOID THE WARRANTY.</b></p>
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## System Alignment

### CMF Optical Alignment



**WARNING:** It is highly recommended that the enclosure safety shielding be utilized for this portion of the alignment procedure to protect from air scattered radiation. Osmic does not assume any responsibility for exposure due to bypassing safety features.

Turn on the x-ray generator. Make sure the electronic shutter is closed!



**WARNING:** Check the anode adapter installation for radiation leaks with a Geiger counter. If any leaks are detected, shut down the generator and reinstall anode adapter.

CMF Alignment

### Rough Alignment

Wait at least a half-hour, preferably one hour, before alignment. The focal spot on the anode takes about one hour to become stable.

#### 1 Mount Alignment Tool

Place the alignment fluorescent tube (if provided) on the exit end of the mirror housing and secure with set screw (see Figure 8). Otherwise, position a fluorescent screen roughly 50-75 mm from the mirror housing output side.

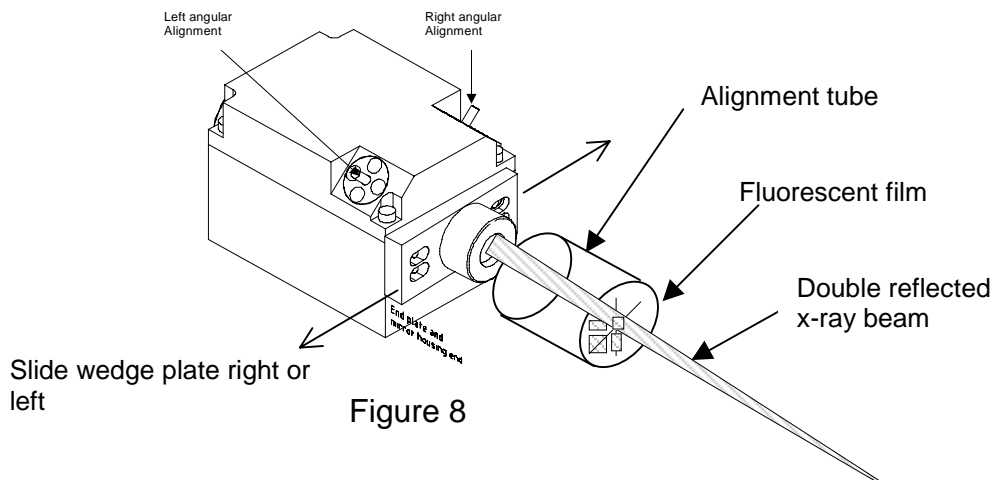




Figure 8

**2 Image the direct beam**

The mirror assembly has two square apertures mounted on the ends of the mirror, forming a square shaped direct beam that may be seen on the fluorescent screen at the end of the alignment tool. Open the x-ray shutter.

	<p><b>WARNING:</b> Check system for radiation leaks with a Geiger counter. If any leaks are detected, shut down the generator and verify all beam pipes and shielding rings are properly installed.</p>
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Adjust the two angular alignment knobs until the direct beam comes through the mirror assembly. The image should be sharp and uniform.

	<p><b>WARNING:</b> Do not place your eye or any body part in the beam path. In some cases, it may be necessary to dim the ambient lighting to see the fluorescence clearly.</p>
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CMF Alignment

If there is any blurred corner, it is likely that part of the direct beam is blocked by some hardware. Turn off the generator and repeat step 3 of the Installation procedure (page 13).

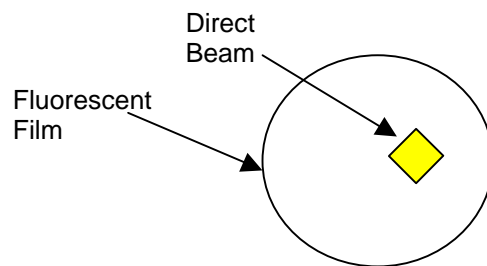


Figure 9



### 3 Image upper mirror reflected beam

Facing toward the source, the left precision screw adjusts the upper mirror and right screw adjusts the lower mirror (Figure 5). Both mirrors are at the left side of the mirror housing. Turning the left screw clockwise will turn the top mirror into the beam and turning the right screw counterclockwise will turn the bottom mirror into the beam. Turn the left screw clockwise using the provided hex wrench until you see two images on the fluorescent screen, the direct beam and the beam reflected by the top mirror (Figure 10). Adjust this screw to obtain the brightest reflected image.

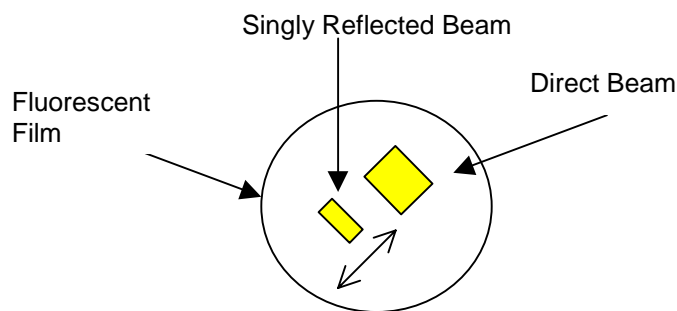


Figure 10

**Important Note: The Bragg reflection profile includes the total reflection region, which will be encountered before the 1<sup>st</sup> order Bragg reflection as this angular adjustment is made. At the distance of the fluorescent screen in the alignment tube, the total reflection and direct beam are coincident, resulting in a brightening of some portion of the direct beam. Additional adjustments will produce the 1<sup>st</sup> order, singly reflected beam we are seeking. At larger distances, the total reflection and direct beams will separate and additional angular adjustment past the total reflection beam is necessary to produce the 1<sup>st</sup> order, singly reflected beam.**

### 4 Image bottom mirror reflected beam and doubly reflected beam

Turn the right adjustment screw counterclockwise, You will see two more reflected images (Look for 1<sup>st</sup> order Bragg reflection per note above). The

spot split from the direct beam is the single reflection beam by the bottom mirror and the spot split from the reflected beam from the top mirror is the doubly reflected beam. The doubly reflected beam is on the opposite corner of the direct beam (Figure 11)

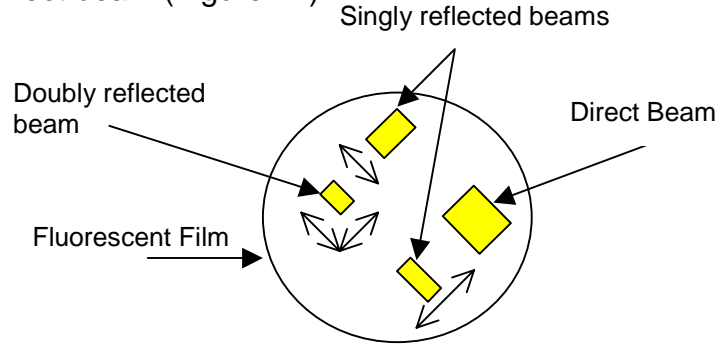


Figure 11

**5 Complete Rough Alignment**

Fine-tune both adjustment screws to get the brightest double reflection. The rough alignment is now complete.

**Final Alignment**

**1 Center the exit beam**

Slightly loosen the 4 socket screws on the wedge plate mounted on the exit side of the mirror housing and adjust until the double reflected beam spot is centered on the fluorescent screen. Secure the wedge plate, close the x-ray generator shutter and remove the alignment tube or fluorescent screen.

**2 Measure Flux**

Use a Pin Diode x-ray counter (or another photon counter) to measure the double reflected beam. Position the counter in such a way that only the double reflected beam falls onto the sensitive area of the detector.

Make sure enough sensitive area of the counter (more than 1 mm) is around the doubly reflected beam because the beam position changes during

CMF Alignment

alignment. You may have to increase the counter's distance in order to isolate the doubly reflected beam. Adjust the right and left angular adjustment screws to get maximum counts. **LOG YOUR READING.** These are the counts at the initial take-off angle and source-optic position. **Do not reposition your pin diode detector for the remainder of the alignment procedure.**

### 3 Readjust the take-off angle

Since the source intensity distribution is different for each source, the optimized take-off angle varies from one source to another. To adjust the take-off angle, translate the mirror housing in the x direction (Figure 4) by turning the x translation hex drive clockwise with the tool provided (decreasing the take-off angle). Do this until the counts have decreased by one-half to one-third of the originally logged value.

### 4 Optimize source-optic position

Adjust the right and left angular adjustment screws to regain maximum counts. **Monitor the double reflected beam location on the detector because it will move.** Compare the counts with the originally logged counts. If the counts increase, a smaller take-off angle will provide larger flux. Repeat above steps until the flux decreases. Then adjust the X translation back to the position of maximum counts. If the counts decrease the first time the take-off angle is decreased, a larger take-off angle will provide more flux. You should adjust the X translation stage in the opposite direction (increased take-off angle) and repeat angular alignment (step 3) until the counts decrease. Then adjust the X translation back to the position of maximum counts.

### 5 Fine adjustment of the optic-source distance

Use the Y translation along the beam line to adjust the mirror position (optic-source distance) along the beam line. Adjust the Y translation along the beam line either clockwise or counterclockwise to change this distance. The

counts will decrease because the mirror is out of Bragg alignment. Adjust the right and left angular adjustment screws on the mirror housing to regain the Bragg angle. Find the position that achieves maximum counts. Usually, the mirror is installed close to the specified position, and the counts are not sensitive to this adjustment.

## 6 Install the beam pipes on the exit side of the mirror housing

If a pinhole pipe is not included, for example in the case of a Mar Image Plate system, just center the doubly reflected beam at the exit (beryllium) window. However, if there is a collimator and pinhole in the system, for example in the cases of Rigaku Image Plate systems and Bruker (Siemens) diffractometer systems, refer to the respective sections of the alignment of diffractometer in this chapter.

**The alignment of optical system is now complete.** The next step is aligning the diffractometer system relative to the beam.

## Diffraction Alignment

### Introduction

The alignment procedure for different diffractometers may look different, but the main goal is the same: align the sample and the center of the detector along the center of the beam line. During the alignment, one should be careful not to alter the alignment of the optical system by touching or bumping the components.

Refer to the following pages for your particular system.

### Mar Image Plate system

#### 1 Set IP nominally

Set all the alignments of the Mar Image Plate system (hereafter IP) at their nominal position. The IP should be elevated to roughly the same height as the beam. Since the beam coming out from CMF system travels in the horizontal plane, the IP should be supported in a level fashion. Systems used with total reflection mirrors have a tilting angle and should have the supporting legs changed (if there are any) in order to have the IP level in the horizontal plane.

#### 2 Open both slits of the IP system

#### 3 Move the IP system into the beam line

Adjust the translation and vertical freedoms to let the beam go through both slits and fall approximately at the center of the image plate.

#### 4 Adjust IP Horizontally

Close the first slit horizontally until the reading of the first ion chamber is reduced by one-third. Align the horizontal traveling freedoms on the IP, both front (sample side) and rear (image plate side), to maximize the reading. Close the second slit horizontally until the reading of the second ion chamber is reduced by one-half or one-third. Adjust the horizontal traveling freedoms, both front and rear but mainly the rear side, to maximize the reading of the

second ion chamber while maintaining the reading of the first ion chamber. With this process, the beam is further aligned with the IP axis horizontally.

## 5 Adjust IP Vertically

Repeat step 4 for the vertical slits.

## 6 Iterate

Repeat the procedures 5 and 6 until the slit size is 0.2 mm. The system is now aligned.

Depending on different sample sizes, a different slit size might be desired. Most commonly used slit sizes are 0.3 and 0.5 mm. For a sample smaller than 0.2 mm, the second slit should be set at 0.3 mm while the first slit should be set at a size larger than 0.3 mm. For a sample larger than 0.2 mm, the first slit should be set at 0.5 mm and the second slit at a larger size. In some cases, if the sample is larger than 0.5 mm, the slit should be set at 0.8 mm or 1 mm. The procedure is described in step 8.

## 7 Complete Alignment

Open the second slit to the desired size. Open the first slit to the same size. The possible asymmetric distribution could cause the reading at this moment to be not optimal. Fine-tune the alignment freedoms, mainly the front side (sample side), both horizontally and vertically to maximize the counts of the second ion chamber. Open the first slit, both horizontally and vertically, until the reading of the second ion chamber no longer increases.

The system should now be aligned. One may take an image or use a fluorescent screen and the built-in microscope to check if the beam is centered on the image plate.

## Rigaku Image Plate (R-axis) or Bruker AXS CCD/Multi-wire Detectors

There are several variations with Rigaku (MSC) and Bruker detector systems. It is very difficult to give a step-by-step procedure for every variation. Fortunately, a guideline is adequate for aligning most systems. When a multi-wire detector is used, extreme precaution should be taken not to expose the detector directly to the x-ray beam. Please refer to the detector manual for assistance

The major challenge in aligning these systems is accurately positioning the heavy goniostat. There is no easy way except using enough manpower. The procedure is as the follows.

- 1 The positioning of the system should be accurate so use sufficient manpower. Measure the distance between the optic and the center of the sample goniometer. Set the distance between the center of the sample goniometer and detector according to the specification.
- 2 Take an image to check if the beam is at the center of the detector. It should be no more than 1 millimeter, at most 2 millimeters from the desired position.
- 3 Repeat step 1 and 2 until the required positions are achieved.
- 4 Use a pinhole or a tooling ball to finely align the goniometer to the beam line. Mount either the pinhole or the tooling ball on the goniometer. Center the pinhole (or tooling ball) by adjusting the goniometer head.
- 5 Attach a small piece of fluorescent screen to the pinhole (or tooling ball), adjust the horizontal position and vertical position so that the bright spot appears at the center of the pinhole (or tooling ball).
- 6 Place a photon counting device behind the goniometer head. In the case of a pinhole, adjust the goniometer head along both horizontal and vertical

directions to get the x-rays going through the pinhole. If there are several pinholes available, use the pinhole with larger diameter first in order to get the x-rays going through the pinhole easily. Then change to smaller pinhole for fine alignment.

- 7 Once the x-rays are aligned and going through the pinhole, further align the position of the goniometer head, both horizontally and vertically, to maximize the count rate. In the case of a tooling ball, adjust the position of the goniometer head so that the tooling ball blocks the x-rays. Finely adjust the position of the goniometer horizontally and vertically to minimize the count in this case.
- 8 Remove the photon counter used for aligning the goniometer head. Take an image with detector to see where the beam spot is. Adjust the detector both horizontally and vertically until its center approaches the center of the beam spot. Repeat this process until the centers of the detector and the beam spot coincide within the required accuracy.

This procedure will in general bring the center of goniometer head out of the beam line. Repeat step 7 to align the goniometer to the beam line. The detector center would in general be brought out of the beam line slightly by procedure 7. Therefore repeat procedure 7 and 8 until both the center of the goniometer head and the center of the detector are in the center of the beam line. The last step should be procedure 7 to make sure maximum photons are going through the pinhole (or sample). For the final alignment, the pinhole size should be comparable with the sample size.

- 9 Remove the pinhole (or tooling ball) from the goniometer head. Install the output beam pipe and the pinhole pipe. Position a photon counter behind the pinhole pipe. Adjust the pinhole pipe so that x-rays go through the pinhole pipe. Adjust the pinhole pipe to get maximum counts.



System alignment is complete.

In the situation where the above procedure does not produce the desired results, the beam can be altered slightly to align with the goniometer head or IP by slightly adjusting the CMF system. To change the beam height, adjust the vertical stage to the desired direction slightly, then adjust the angular alignment to get maximum counts. To change the beam position horizontally, adjust the translation stage cross the beam, then adjust the angular alignments again to get the maximum counts. The beam direction should not be changed much from the original alignment, while the beam counts will drop due to deviation from its optimized position.

### General Systems

There are many other types of diffractometers, including numerous user designed and implemented systems. Although alignment procedures could be different for different diffractometers, it is not difficult for a user to develop a procedure for a particular diffractometer by referring to the procedures discussed above. The main goal in the alignment is to place the sample and the center of the detector on the center line of the beam. If the sample holder is not physically connected with the detector, the sample holder and the detector can be aligned separately. If they are connected like the systems we discussed in the previous sections, the alignment of the system will require an iterative approach. This means the alignment should include aligning the sample holder and the detector alternatively many times, until the sample has maximum flux and the beam spot is close enough to the center of the detector. The last alignment should always be for the sample. In general, once a system is aligned, the alignment of a diffractometer system should not be adjusted further. Misalignment happens from time to time due to various reasons. However, alignment can usually be regained by simply adjusting the CMF optic. The original flux should always be

recorded as recommended in the "Operating Notes" section. Future alignment should treat this reading as a reference to judge if proper alignment is attained.

## Trouble Shooting

Osmic CMF systems have very few failure modes. Almost all result in the post-optic flux being lower than expected. Thus, flux level is a key indicator of the systems performance. The following possible problematic situations and corrective actions are most common.

1. After x-ray generator maintenance, the flux is much larger than before.

If the focal cup was changed, the new focal cup provides better focusing (smaller focal spot). If the bias was changed, the new bias gives a better focus. If the sample position was moved towards the focus, more photons are going through the pinhole for a focusing optic. If nothing was changed, the alignment of the original equipment was incorrect.

2. After turning on the generator, the flux is much lower than obtained just prior to turning off the generator.

Wait for about one hour and see if the flux recovers its original value. Multilayer optics are very sensitive to the focal spot position. The filament of the focal cup will deform when heated. Some other reasons could also affect the focal spot position. It takes some time for the system to become stable. If the flux is still lower, most likely the alignment is somehow changed. Do not try to align the optical system to obtain the original reading at the first moment you turn on the generator. If you do, you will find the flux decreases with time during the time that the generator becomes stable.

3. When increasing the power loading, the flux does not proportionally increase.

Flux should have very good linearity with anode current, but not voltage. Sometimes, the flux seems truly not very linear with anode current. Since more heat is applied on the filament and anode if the power loading is increased, the heat will change the focal spot position. Try to align the optical system slightly 20 minutes after you change the power loading. The installation and alignment, including diffractometer alignment, should be done with a lower power loading for

the sake of safety (for example, 50 kV and 20 mA for 0.3 mm source). It is always recommended to align the optical system (only the optical system, not diffractometer) one more time at the power loading with which you will proceed with your experiment. With all these alignments, if the flux is still not proportionally increase with anode current, check the detector first and see if it has a linear response.

4. The flux suddenly decreases and alignment does not recover the flux.

Change the bias and see if the flux changes. If not, the bias device is faulty. See equipment manufacturer recommendations.

5. After x-ray generator maintenance, the original flux level cannot be reached.

First, wait about one hour to stabilize the anode. Then if the flux is still low, the reason is most likely that the position of the focal spot changed. Try to align the optical system as well as adjust the bias a slightly.

6. When a vacuum pump is turned on, flux decreases dramatically and/or the reflected beam disappears.

For a system designed for vacuum, the optical alignment should be done under vacuum. The alignment could be changed under the force applied by the vacuum, since the multilayer is a Bragg reflector and is very sensitive to the angular position.

7. No detectable flux at all.

The system is out of alignment. Repeat the alignment procedure beginning at page 14.

If the information in this section does not help you solve your problem, please contact Osmic, Inc. for technical support at 248-362-1290.

## Operating Notes

It is always very helpful to keep a record every time you change the alignment, whether due to anode maintenance, misalignment, or system configuration change. The record should include any system and performance parameters you think worthy of tracking. These might include accurate measurement of take-off angle, distance between optic and sample, distance between sample and detector, flux with specific system settings such as power loading, bias applied to the focal cup, and pinhole size. Anything that is abnormal should also be kept on the record. This information will be very useful for system diagnosis if anything goes wrong. The parameters recorded from the installation are especially critical, as future installations and alignments should use these parameters as a reference.