KAPPA Series II Motorized Alignment Base

Procedure

Purpose

This Procedure covers using the KAPPA Series II Motorized Alignment Base to align the goniometer to the beam.

Responsibility

These procedures are to be performed only by trained Bruker AXS personnel or by locally-authorized persons.

Disclaimer

All configurations and specifications are subject to change without notice.

Required Items

The following Table contains a list of items required for the Procedure. It is necessary to have these items available as you work with the Procedure.

Item	Description
Pin diode	Part number 472-050100
Black plug reference tool	Part number 173667
Half-beam alignment pipe and half-beam goniometer head tool	Part number 164870

Required Items

Referenced Documentation

The following Table contains a list of documentation referenced in the Procedure. It is necessary to have this additional documentation available as you work with the Procedure. In the documents' part numbers, a variable revision number is indicated by a lower-case letter "x". Always use the most current revisions available.

Part Number	Title
<none as of this publication>	

Referenced Documentation

Time Required

A minimum of 2 hours is required for this Procedure.

1 Before You Begin

1.1 Pre-installation Considerations

Before you start using the alignment base to align the goniometer to the beam, verify the following:

- You must be using BCP version 2.0.2.8 or later.
- Make sure that the beam, exiting the rotating anode's optics, is parallel to the surface the goniometer will be sitting on (e.g., the rotating anode's countertop). This is typically done at the factory. This minimizes the danger of the alignment base's drives moving beyond their ranges during the alignment procedure.

CAUTION

Do not use the KAPPA Series II alignment base on surfaces tilting more than 3° from level. The base was designed for horizontal goniometer orientations only.

- Once the alignment base is properly positioned, it will need to be secured to the countertop with screws or glue.
- Be sure that the alignment base's hoovers are positioned over flat, smooth surfaces without cracks or holes. If there are cracks or holes in the surfaces beneath the hoovers, air will leak out and the alignment base will not elevate.

CAUTION

Make sure that you are familiar with the movements of the alignment base and the base's controls in BCP before attempting any movement! Following an incorrect procedure for moving the alignment base can damage the base.

CAUTION

Moving the alignment base without the hoovers turned on may scratch the undersides of the hoovers, making it impossible to elevate the alignment base!

1.2 Movement and the Hoovers

The alignment base has three types of movement:

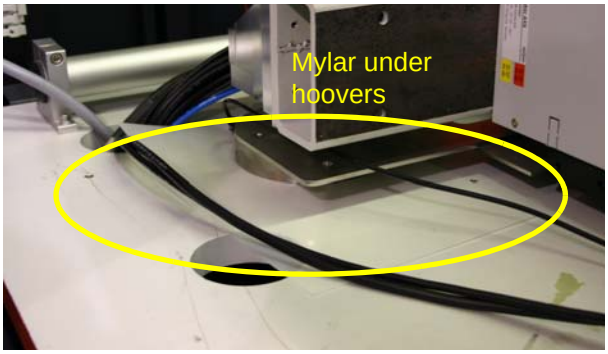
- Lateral translation toward and away from the tube tower;
- Rotation of the entire alignment base about an axis perpendicular to the tabletop; and
- Up-and-down translation (i.e., toward and away from the tabletop) of three points which contribute to rotation of the alignment base about the beam axis and about the axis parallel to 2-theta when 2-theta = ±90°. These up-and-down translations are labeled on the alignment base:
  - Left
  - Right
  - Front

During translation and rotation, the alignment base rests on a cushion of compressed air from the *hoovers*, which negate friction caused by the mass of the goniometer. Compressed air to the hoovers may be turned on by clicking the “Hoovers” button in BCP’s **Tools > Manual** window, by using the AC1 command in D8Tools, or by opening a manual valve on the hoovers’ air lines.

Rotation and Translation of the alignment base require the hoovers to be ON; elevating the Left, Right, and Front actuators do not require the hoovers to be on.

NOTE: If there are any inconsistencies in the surface, the alignment base will not travel (e.g., because air leaks out from under a crack or because two pieces of the surface have slightly different heights).

If this occurs, you can solve the problem by placing mylar sheets under the hoovers.



Motor	Function	D8 Firmware Logical Drive #
Front	Elevates the goniometer at a point directly under the collimator support.	12
Left	Elevates the goniometer on the detector/positive 2-theta side.	13
Right	Elevates the goniometer on the detector/negative 2-theta side.	14
R1	Works with R2 to rotate the goniometer about a selectable pivot point (i.e., the collimator exit, collimator entrance, or the crystal position), or move the goniometer left and right relative to the beam.	15
R2	Works with R1 to rotate the goniometer about a selectable pivot point (i.e., the collimator exit, collimator entrance, or the crystal position), or move the goniometer left and right relative to the beam.	16

Table 1.1 — Alignment base motor functions

Tilt (about x-axis)	+ 2.5°
Roll (about z-axis or beam axis)	+ 5°
Yaw (about y-axis, under the monochromator)	+ 2°
X (horizontal, TRANS)	46 mm adjustable range
Y (vertical)	30 mm adjustable range

Table 1.2 — Base adjustments

NOTE: All mechanical adjustments are based on pre-loaded screw assemblies to minimize backlash and eliminate drift.

NOTE: Translation of the alignment base toward and away from the tube tower is not motorized, but still requires the hoovers to be on.

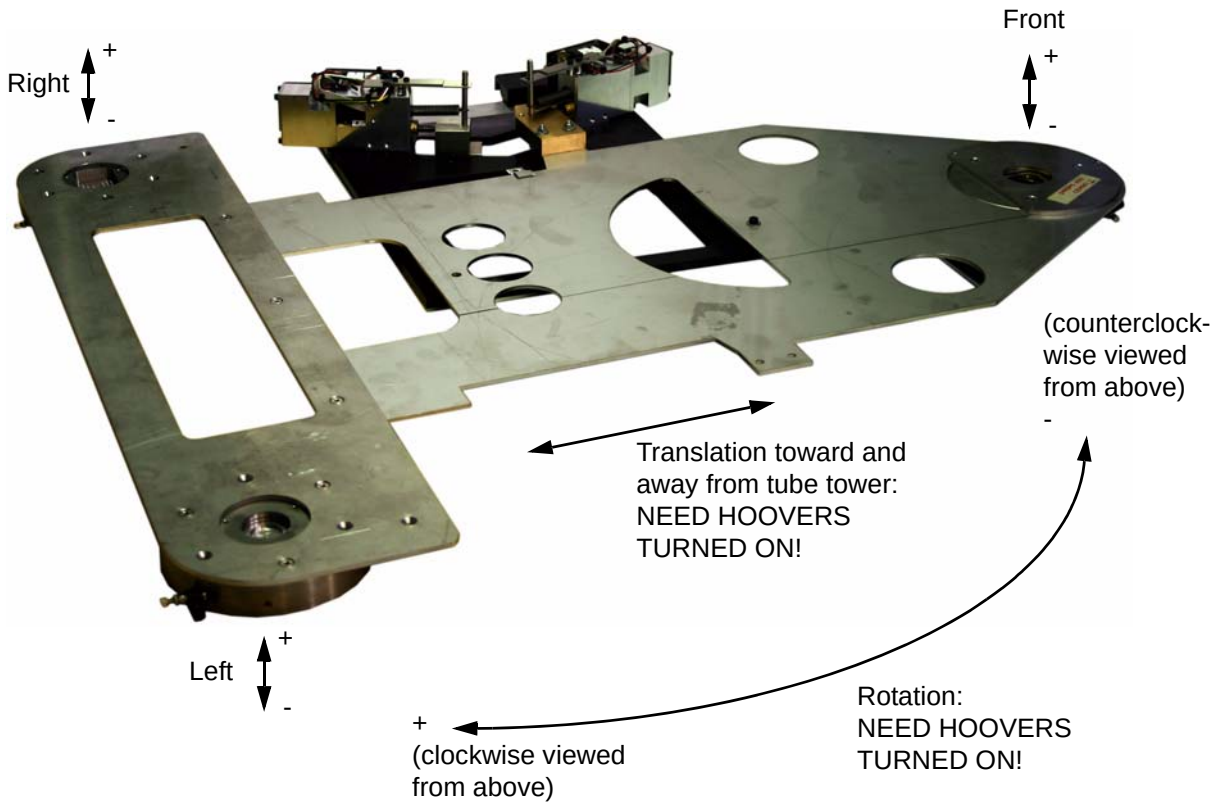


Figure 1.1 — Alignment base conventions

1.3 Configuring BCP for the Alignment Base

1. Under “Instrument” in BCP’s left-hand pane, choose “Configuration”.
2. Activate the “Base” checkbox.

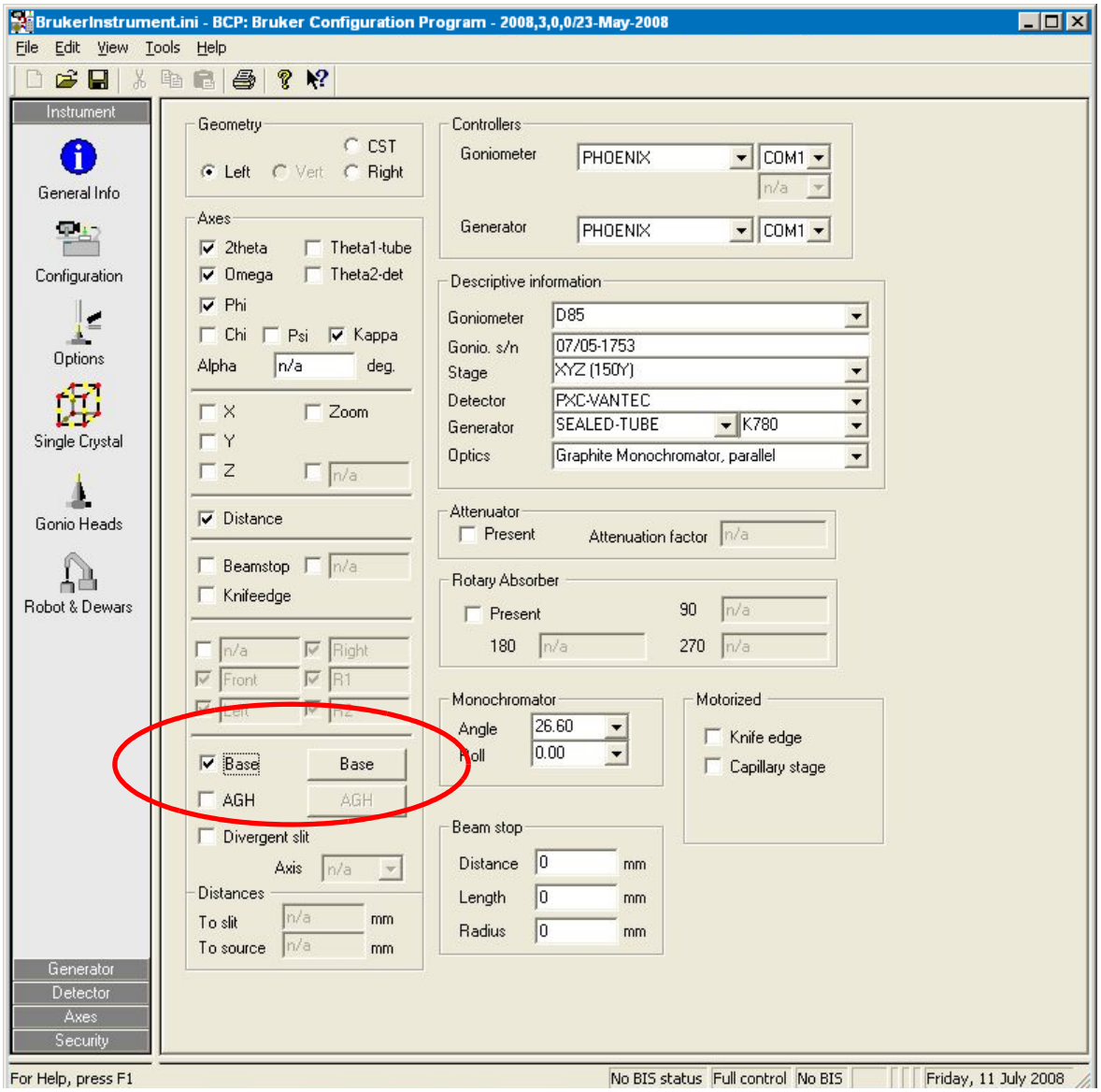


Figure 1.2 — BCP: Configuration

3. Click the **Base** button. The Alignment Base Parameters window opens.

4. Set the parameters (Figure 1.3):
    4.1. Choose the orientation of the alignment base: Left, Center, or Right.
    4.2. Set the sample height to 420 mm.
    4.3. Activate the first two checkboxes in the “Pivots” list. Set the distances as appropriate.
    4.4. Click **OK**.

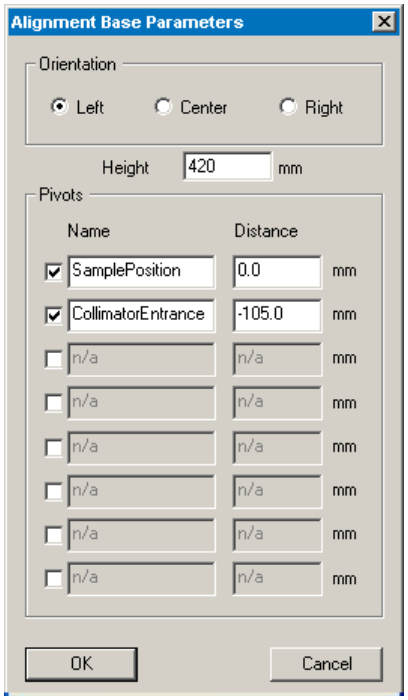


Figure 1.3 — Alignment base Parameters

5. Under Axes, click **Aux3**, **Aux4**, **Aux5**, **Aux6**, and **Aux7**. Each time, BCP will display the “Automatically defaulted incorrect settings” alert (Figure 1.4). Click **OK**.

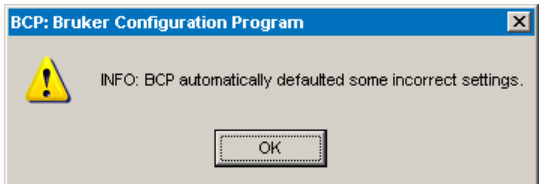


Figure 1.4 — Alert: BCP automatically defaulted some incorrect settings

6. Choose **File > Save**. BCP alerts you that it has updated the brukerinstrument.bak backup file (Figure 1.5). Click **OK**.

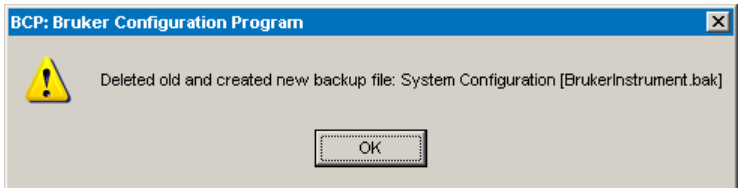


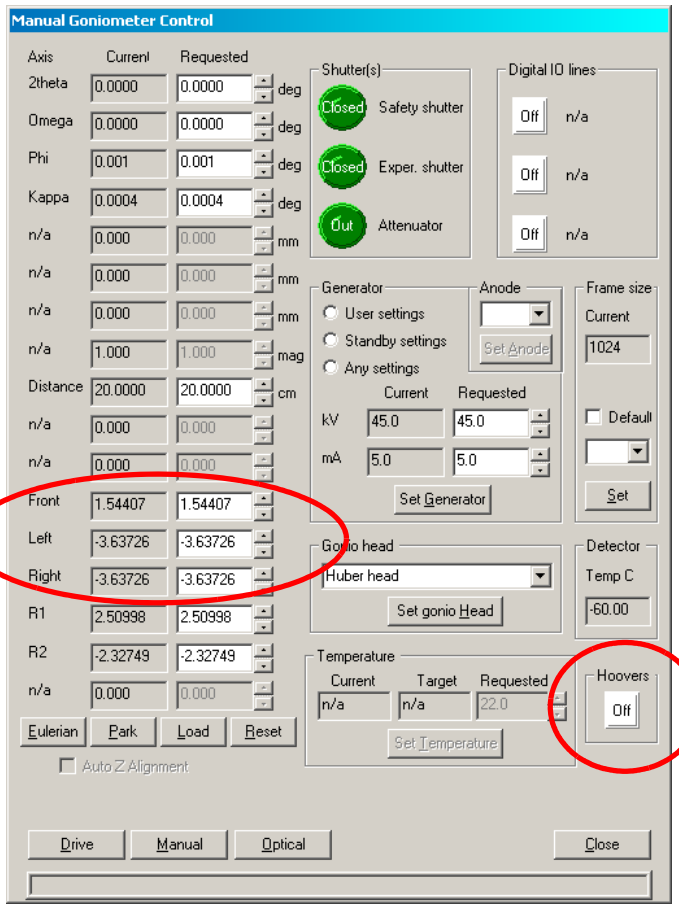
Figure 1.5 — Alert: BCP deleted old and created new backup file

1.4 Alignment Base Controls in BCP

BCP contains all the commands and features you need to properly position the alignment base. All of these commands are available in BCP (version 2.0.2.8 or later) from the **Tools > Manual** and **Tools > D8 Align Base** windows.

NOTE: In order to see menu options for the alignment base in BCP, choose **View > Align Base**.

1.4.1 Tools > Manual



Do not move R1 or R2 in Manual Mode. Rotation is available under **Tools > Align D8 Base**.

Figure 1.6 — BCP's **Tools > Manual** window

1.4.2 Tools > Align D8 Base

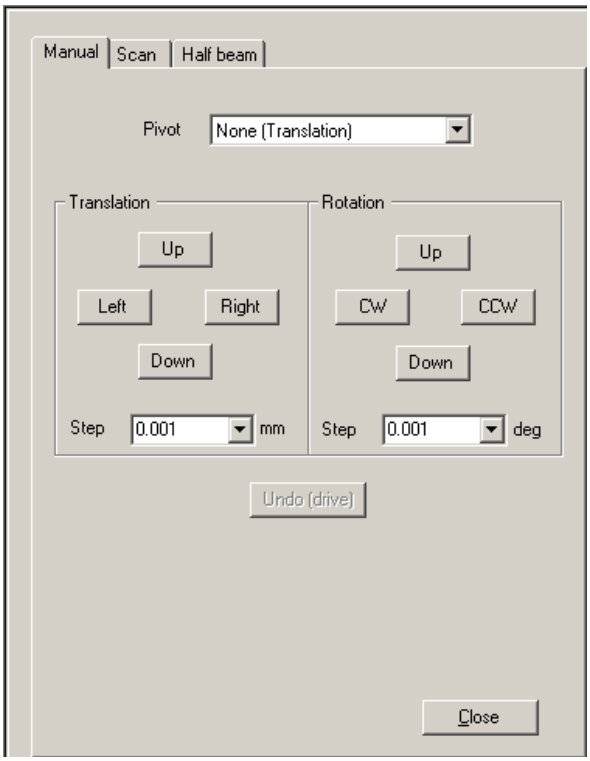
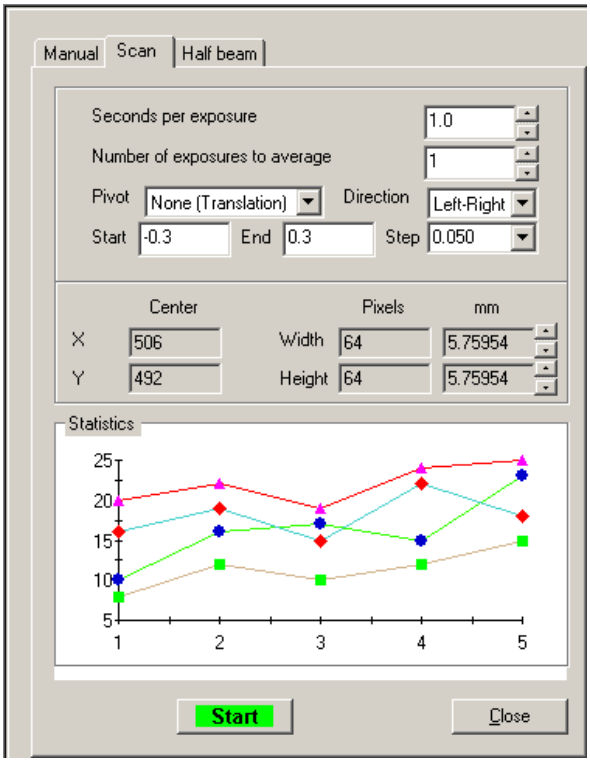


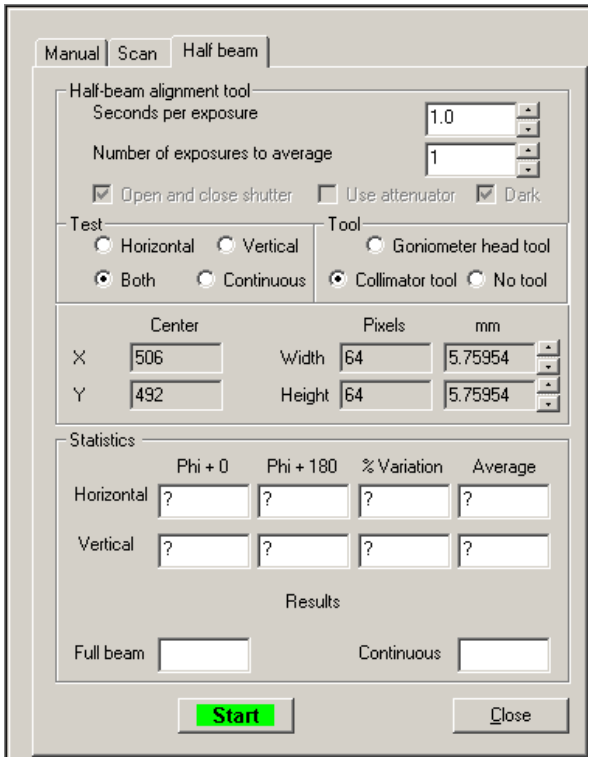
Figure 1.7 — BCP's Tools > Align D8 Base window: "Manual" tab

Command	Function
Pivot	Options: None (Translation), CollimatorExit, CollimatorEntrance, Crystal.
Translation buttons	Move the entire base up, down, right, or left.
Translation: Step	Specify the "coarseness" of the base's movement in response to translation button input.
Rotation: Up and Down	Rotate the entire base, on the selected pivot, about an axis parallel to 2-theta = ±90°.
Rotation: CW and CCW	Rotate the entire base clockwise or counterclockwise.
Rotation: Step	Specify the "coarseness" of the base's movement in response to rotation button input.
Undo (drive)	After driving, click this button to return the alignment base to its former position.



Command	Function
Seconds per exposure	Set the duration of each exposure in seconds.
Number of exposures to average	If desired, average together multiple exposures for each reading.
Pivot	Options: None (Translation), CollimatorExit, CollimatorEntrance, Crystal.
Direction	Options: Left-Right, Up-Down. Set the direction of the scan.
Start and End	Set the range of movement for the scan.
Step	Set the intervals at which exposures are taken when building the graph.
Detector face parameters	Set the location and size of the detector region that records counts.
Statistics	The graph shows the counts in the active area as a function of the scan direction.
Start	Start the scan.
Close	Return to the BCP Main Window.

Figure 1.8 — BCP's Tools > Align D8 Base window: "Scan" tab



Command	Function
Seconds per exposure	Set the duration of each exposure in seconds.
Number of exposures to average	If desired, average together multiple exposures for each reading.
Test options	Set the direction(s) to be evaluated in the half-beam test.
Tool options	Specify which tool is currently being used for the half-beam test. "No tool" is used to find a total value against which to compare the half-beam values.
Detector face parameters	Set the location and size of the detector region that records counts.
Statistics	Reads the outputs at the various positions of the half-beam test. In an optimum alignment, the % Variation value will be 0%.
Results	Gives the total intensity of the beam and measures it continuously as a ratemeter.
Start	Start the scan.
Close	Return to the BCP Main Window.

Figure 1.9 — BCP's Tools > Align D8 Base window: "Half beam" tab

2 Installing the Alignment Base

2.1 Installing the Alignment Base Under the Goniometer

1. Elevate the goniometer on 2×4 wooden blocks.

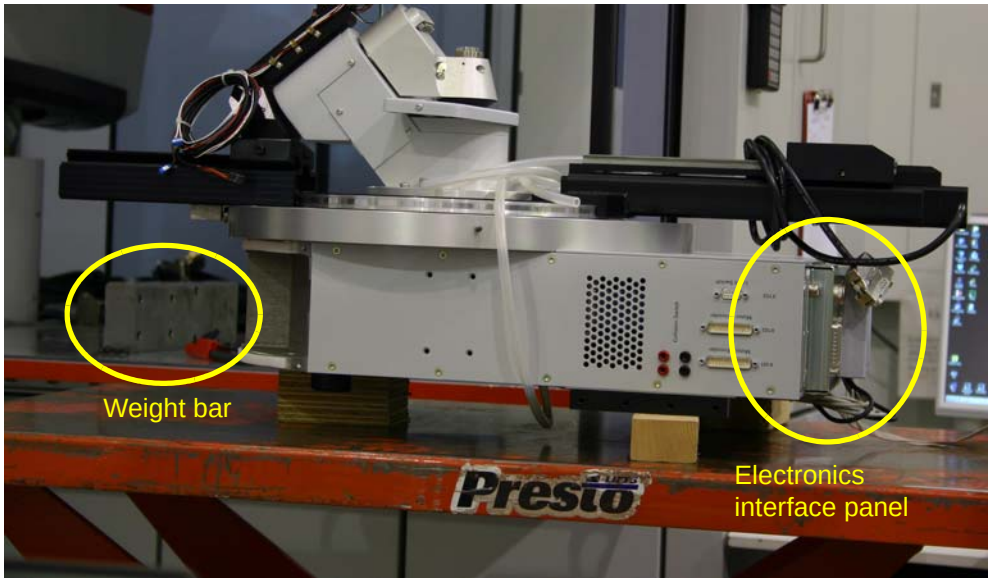


Figure 2.1 — Goniometer elevated on 2×4 blocks

2. Affix the curved panel to the source side of the goniometer (it is removed during shipping).
3. With the goniometer elevated, attach the Z vertical drive to the source side of the goniometer with four socket head screws.
4. Remove the electronics interface panel (circled in Figure 2.1) from the detector side of the goniometer. Set it aside without unplugging the cables.
5. Attach the weight bar (circled in Figure 2.1) with the X and Y horizontal drives to the detector side of the goniometer using four socket head screws.
6. Attach the electronics interface panel to the weight bar using the same screws that attached it to the side of the goniometer. If there is a problem getting the cables to reach, check the cables' routing under the goniometer.

3 Initial Positioning of the Alignment Base

3.1 Initialize Motors in D8Tools

We are going to want to make sure that the motors are all zeroed at their reference markers (i.e., in the middle of their ranges) before securing the alignment base to the table. In D8Tools:

1. Do a `RC1` and `LD0` to unlock all the drives.
2. Under the axis position dialog, choose the axis of interest: Front, Right, Left, R1, or R2. For each:
    2.1. Scan UP or Scan DOWN to find the reference marker.
    2.2. **For the alignment base's motors ONLY**, after you have found the reference marker, you must manually update the motor's position to 0 using the command prompt. For example:
    `RC1`
    AV<logical drive number>`,0`

3.2 Find the Optimum Initial Position for the Alignment Base

We will first find an optimum position for the alignment base relative to the tube tower using the black plug reference tool. Once this optimum position is found, we will secure the alignment base to the tabletop, move the base outward to remove the plug, and then move the base back inward to an initial position for coarse X-ray alignment.

1. Insert the black plug reference tool into the collimator adapter (or "pipe"). The black plug reference tool shows whether the collimator adapter is parallel to the optics' exit port.

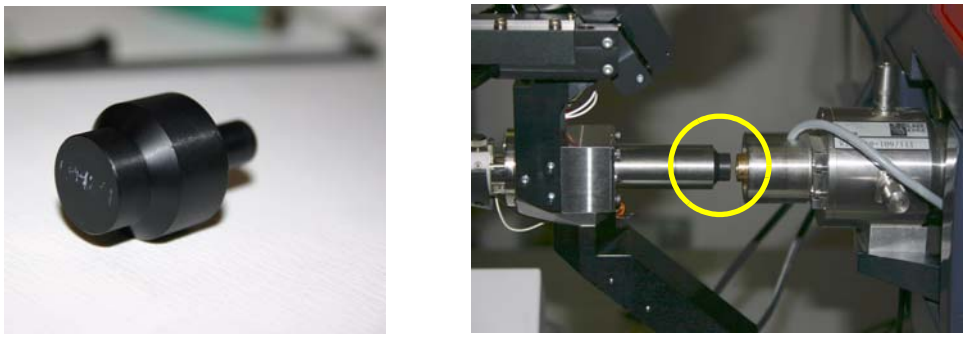


Figure 3.1 — Black plug reference tool

2. Turn on the hoovers.
    2.1. In BCP, choose **Tools > Manual**.
    2.2. In the Manual Mode window, click the "Hoovers" button in the lower right-hand corner.
3. With the hoovers activated, gently push the alignment base along the tabletop until the black plug reference tool lines up as nearly as possible with the optics' exit port. The flat surface of the black plug reference tool should be both parallel to and concentric with the optics' exit port.

NOTE: If the optics' exit port does not match up to the collimator adapter, use the alignment base's vertical translation adjustments to position the goniometer properly. If you cannot get the heights to match, you may have to adjust the height of your rotating anode tube tower.

4. Turn off the hoovers.

3.3 Secure the Alignment Base to the Tabletop

1. Mark the position of the alignment base on the tabletop, and secure it to the tabletop with screws or glue (Figure 3.2). This will provide counterpressure for the alignment base when you start using the rotation adjustments; without the base secured down, the pivot plate would move and the rest of the alignment base would not.

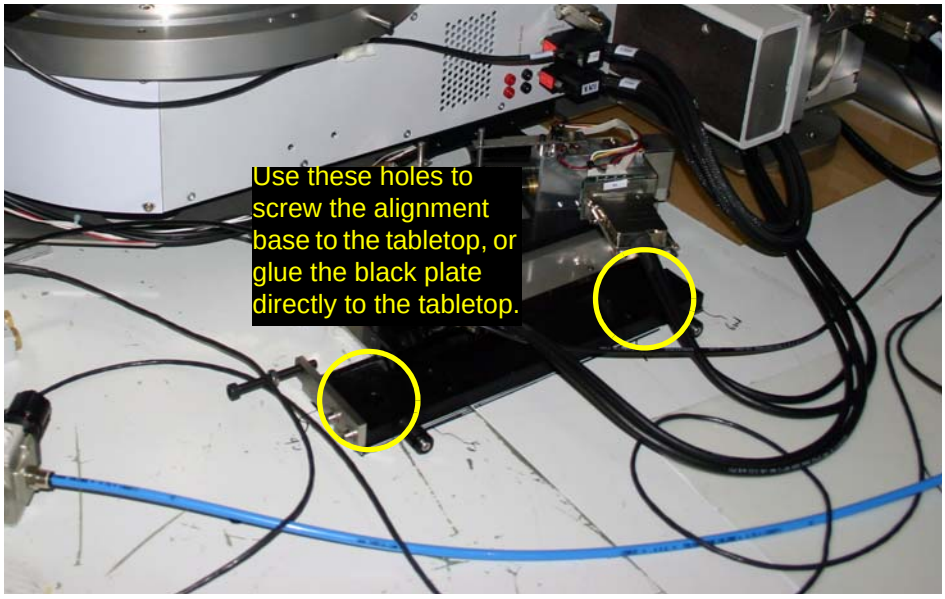


Figure 3.2 — Screwing the alignment base to the tabletop

3.4 Mate the Alignment Base to the Optics

1. Turn on the hoovers.
2. Slide the alignment base outward away from the tube tower (the alignment base moves along a track).
3. Remove the black plug reference tool.
4. Slide the alignment base back inward so that the optics' exit port mates to the collimator adapter.
5. Turn off the hoovers.

4 Coarse X-ray Alignment

When the alignment base is properly positioned and the goniometer is oriented so that the optics mate with the collimator adapter, begin moving the alignment base so that the beam goes through the collimator.

NOTE: Use an open-bore collimator for the coarse X-ray alignment procedure.

4.1 Maximize Counts by Moving the Alignment Base

1. Place a pin diode on the end of the open-bore collimator.
2. Set the power to a typical power setting for the system (for MICROSTAR, approximately 45kV, 60mA).
3. Turn on the hoovers.
4. Open the shutter. If the goniometer is aligned to the optic, you should see a voltage reading from the pin diode. If not, push the goniometer around to see if you can, by trail-and-error, find the beam. If you still do not see a reading from the pin diode, try turning up the power to see whether the beam is hitting the inside of the collimator at an angle.
5. Move the goniometer around until you have maximized the reading from the pin diode.
6. Turn off the hoovers.

4.2 Maximize Counts by Driving the Alignment Base Motors

1. If you have not already done so, open BCP and choose **View > Align Base**.
2. Choose **Tools > D8 Align Base**. The Alignment base window opens with the “Manual” tab activated.
3. Under the Pivot drop-down menu, choose **None (Translation)**.
4. Move the alignment base, in one direction at a time, while watching the pin diode to maximize the reading:
    4.1. Under “Translation”, click **Up** and **Down** to maximize the reading.
    4.2. Under “Translation”, click **Left** and **Right** to maximize the reading.
    4.3. Under “Rotation”, click **Up** and **Down** to maximize the reading.
    4.4. Under “Rotation”, click **CW** and **CCW** to maximize the reading.

CAUTION

When maximizing the counts, pay special attention to the junction between the collimator adapter and the optic to make sure that the alignment base's motion does not cause binding or stress.

NOTE: Make sure that compressed air is adequate for the hoovers while translating the alignment base. BCP automatically turns the hoovers on when required, but inadequate air pressure to the hoovers may cause mechanical stress as the alignment base moves.

NOTE: It is advisable to go back and double-check the readings in each direction, because the adjustments may interrelate.

5. When the readings are maximized in each of the eight directions available in **Tools > D8 Align Base**'s "Manual" tab, replace the collimator with the next smallest collimator (actual collimator sizes may vary depending on your optics).
6. Repeat steps 4 and 5 until coarse alignment is completed for the smallest collimator.

When coarse alignment is completed for the smallest collimator, proceed to fine alignment with the half-beam procedure (Section 5).

5 Fine X-ray Alignment with the “Half-Beam” Procedure

The “Half-beam” procedure requires an iterative alignment starting with alignment at the collimator entrance position, followed by alignment at the crystal position, and ending with alignment at the collimator entrance position.

Use the half-beam alignment pipe (i.e., the one with the dots, circled in Figure 5.1) for the half-beam test at the collimator entrance position.

Use the half-beam goniometer head tool for the half-beam test at the crystal position.

Figure 5.1 — Half-beam alignment pipe (dots circled), half-beam goniometer head tool

NOTE: Though the half-beam test may be performed without opening the enclosure, the half-beam test requires a beamstop override.

5.1 The “Half-Beam” Test at the Collimator Entrance Position

5.1.1 Vertical Test

1. Under the “Half beam” tab, choose:
   - Seconds per exposure: 1.0
   - Test: Vertical
   - Tool: Collimator tool.
2. Click **Start**. BCP prompts you to insert the half-beam alignment pipe in position 1 (3 for the second iteration).
3. Place the half-beam alignment pipe in the collimator support according to BCP’s instructions and mount the attenuator and beam stop override. Click **OK**.

   BCP displays the intensity in the “Statistics” area, and the frame display window shows the beam and integration box. Be sure that the beam is within the integration box; if necessary, enlarge the Width and Height to 100 × 100 pixels.

   If the beam is still not in the integration box—but clearly on one of the edges—repeat Section 4. If this does not help, the goniometer pitch may be incorrect and you should contact a Bruker AXS Field Service Engineer for assistance in setting the goniometer pitch and level.

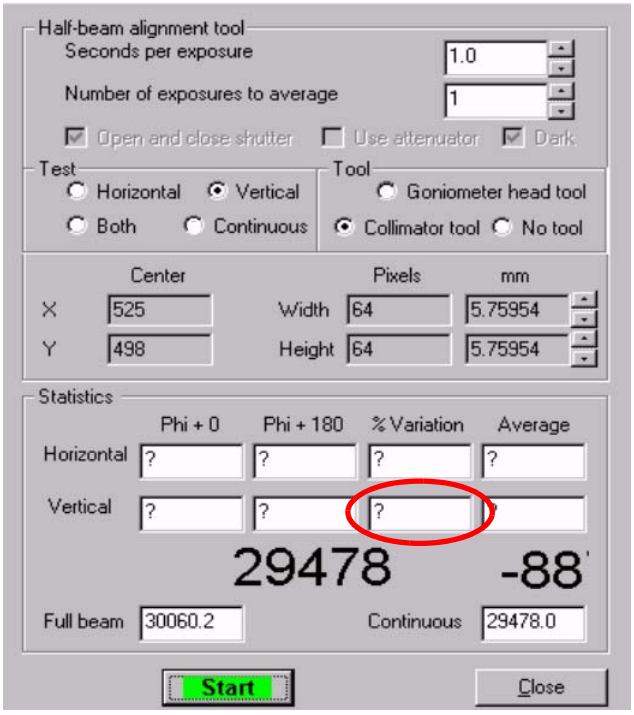


Figure 5.2 — Vertical test

4. Activate the “Manual” tab and slightly adjust the vertical translation of the alignment base at the collimator entrance position to reduce the Vertical % Variation (Figure 5.2). Be sure that the pivot point is set to “CollimatorEntrance”. Return to the half-beam tab.
5. Repeat steps 2 to 4 until the Vertical % Variation field is less than 5%.

5.1.2 Horizontal Test

1. Under the "Half beam" tab, choose:
   1.1. Seconds per exposure: 1.0
   1.2. Test: Horizontal
   1.3. Tool: Collimator tool
2. Click **Start**. BCP prompts you to insert the half-beam alignment pipe in position 2 (4 for the second iteration).
3. Place the half-beam alignment pipe in the collimator support according to BCP's instructions and mount the attenuator and beamstop override. Click **OK**.

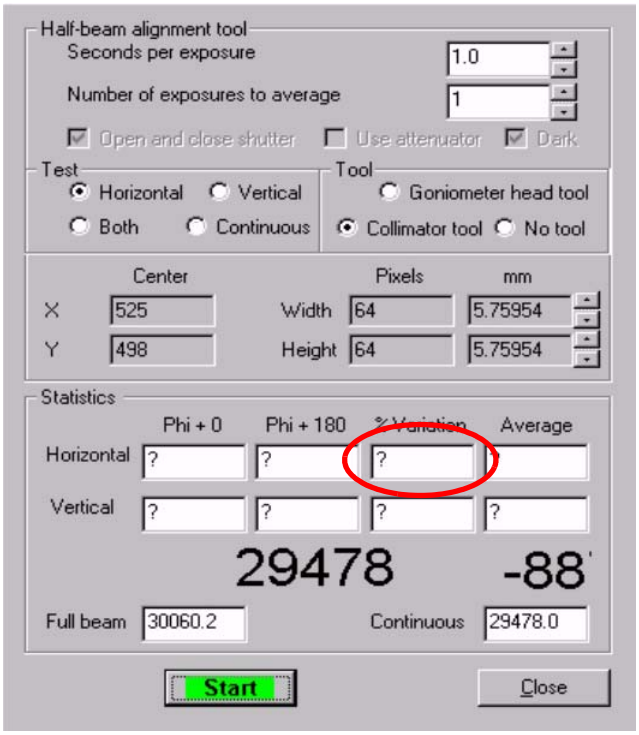


Figure 5.3 — Horizontal test

4. Activate the "Manual" tab and slightly adjust the horizontal translation of the alignment base at the collimator entrance position to reduce the Horizontal % Variation (Figure 5.3). Be sure that the pivot point is set to "CollimatorEntrance". Return to the "Half beam" tab.
5. Repeat steps 2 to 4 until the Horizontal % Variation field is less than 5%.

5.2 The “Half-Beam” Test at the Crystal Position

1. Place the open-bore collimator in the collimator support.
2. Place the half-beam goniometer head tool in the goniometer head mount.
3. Use the video microscope and the crystal alignment routines (e.g., Proteum2Server’s **Center Crystal** module) to align the half-beam goniometer head tool such that it obscures one half of the beam at one position of phi, and the other half of the beam when phi is moved 180°.
   In Optical mode, press the **Right** button, and then press **Spin Phi 90**. Make sure that the goniometer head tool is in the top portion of the display.
4. From BCP, choose **Tools > D8 Align Base**.
5. Activate the “Half-beam” tab.

5.2.1 Vertical Test

1. Under the “Half beam” tab, choose:
   - Seconds per exposure: 1.0
   - Test: Vertical
   - Tool: Goniometer head tool.
2. Click **Start** to measure the beam intensity above and below the half-beam goniometer head tool with the automated beam alignment routine.

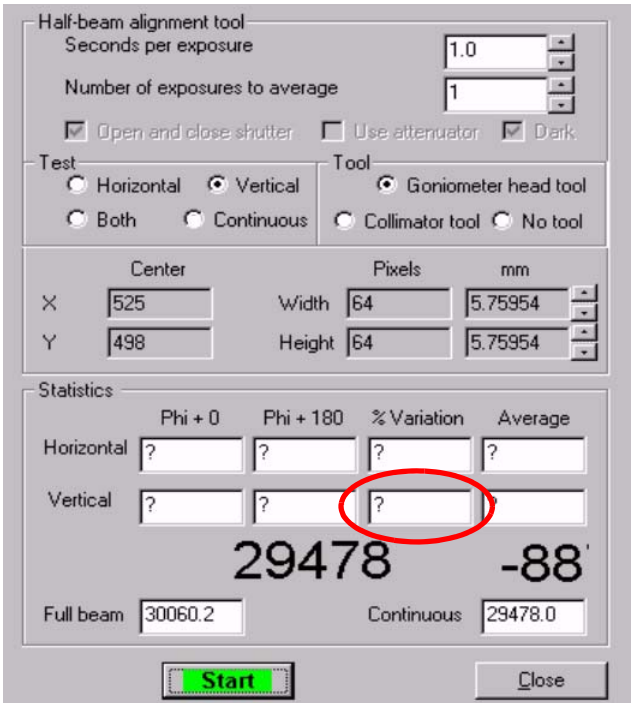


Figure 5.4 — Vertical test

3. Activate the “Manual” tab and slightly adjust the height of the alignment base at the crystal position to reduce the Vertical % Variation (Figure 5.4). Be sure that the pivot point is set to “Crystal”. Return to the “Half beam” tab.
4. Repeat steps 2 to 3 until the until the Vertical % Variation field is less than less than 10%.

5.2.2 Horizontal Test

1. Under the “Half beam” tab, choose:
   - Seconds per exposure: 1.0
   - Test: Horizontal
   - Tool: Goniometer head tool.
2. Click **Start** to measure the beam intensities to the left and right of the half-beam goniometer head tool with the automated beam alignment routine.

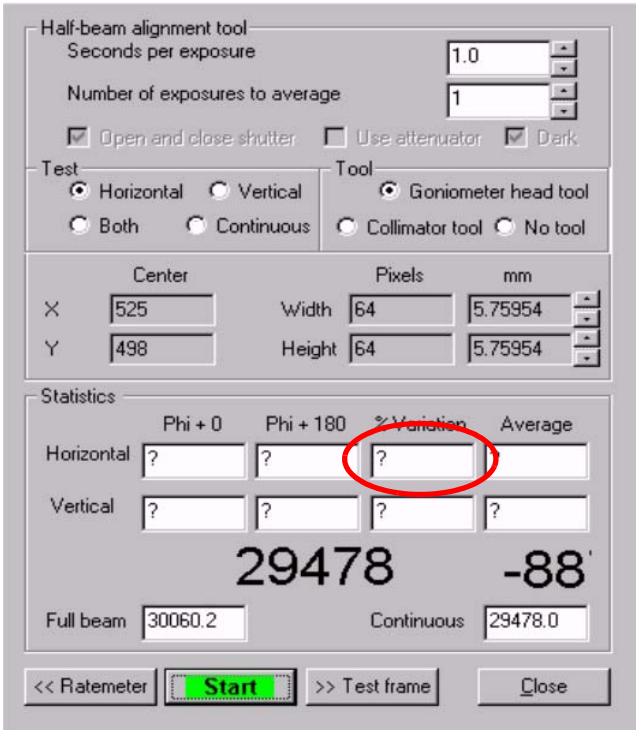


Figure 5.5 — Horizontal test

3. Activate the “Manual” tab and slightly adjust the horizontal translation of the alignment base at the crystal position to reduce the Horizontal % Variation (Figure 5.5). Be sure that the pivot point is set to “Crystal”. Return to the “Half beam” tab.
4. Repeat steps 2 to 3 until the Horizontal % Variation field is less than 10%.
5. Remove the half-beam goniometer head tool from the goniometer head mount.

5.3 Repeat the “Half-Beam” Test at the Collimator Entrance Position

Repeat the “half-beam” test at the collimator entrance position (Section 5.1) and at the crystal position (Section 5.2) until you have reduced both the Horizontal and Vertical % Variation to less than **5%** in both the collimator entrance and crystal positions.

NOTE: If the alignment was changed significantly, it is advisable to repeat the procedure. Always end the alignment at the crystal position.

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