

9-BM Alignment Procedure

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9-BM Alignment Procedure

June, 2004

In general, beamline alignment is to be done in a series of passes, rather than optimizing at one particular spot along the beamline and for one particular beam attribute before proceeding to the next. This insures that beam is incident in the B-station at all times.

I. Focusing (First Pass):

***Getting Started:**

Cold Start:

1. Verify that beam is incident on Flag 1. If beam is not in Flag 1, then open vertical White Beam Slits (WBS) to approximately 1.5 mm, find the beam, and then close back down to .2 to 4. mm.
2. Change energy to 8 keV so that Flag 2 is visible.
3. Look at Flag 2 to verify that beam is getting past the monochromator crystals. If there is no beam, then tweak θ until beam intensity is acceptable.

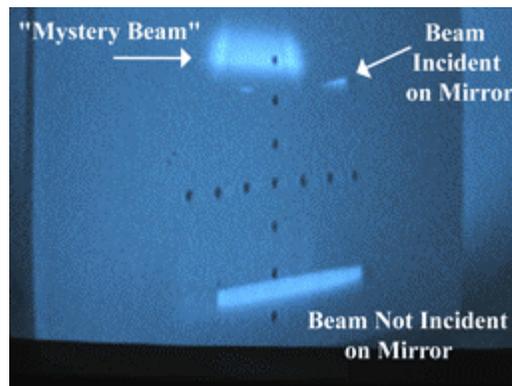
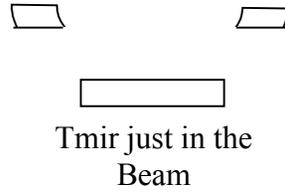
Otherwise:

4. Next, go to Flag 3. There should be two distinct beams present.
5. Tweak θ in order to find “real” beam. The “real” beam will drop suddenly in intensity when θ is tweaked. Tweak θ to find optimal intensity visually.
6. Go to Flag 5. Drop the Toroidal Mirror (Tmir) out of the beam completely. Use the holes to monitor the beam position; center Flag 5 vertically on the beam, and close the White Beam Slits (WBS) horizontally such that the width of the real beam is no wider than the space that the holes on the flag span.
7. Change energy (decrease) by approximately 5 keV, while watching the beam position. The intensity distribution and position should not change with changing energy. The vertical position of the horizontal holes on Flag 5 should be -54.5 mm^1 . If the beam intensity drops off, tweak θ to increase again.
8. Once the beam is optimized this far, Tmir should be optimized. Slowly move Tmir up into the beam, just such that the bottom is still cut off. If the mirror is in a good

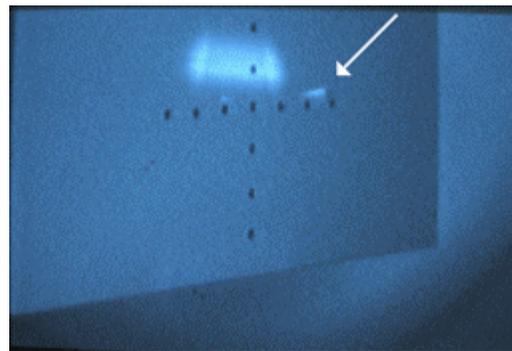
¹ Note: The numbers given in this procedure are guidelines; after beam dumps in the storage ring, the position of the x-ray beam can change.

position, the shape will be symmetric and horizontal. Note: the holes on Flag 5 have been leveled such that they are horizontal.

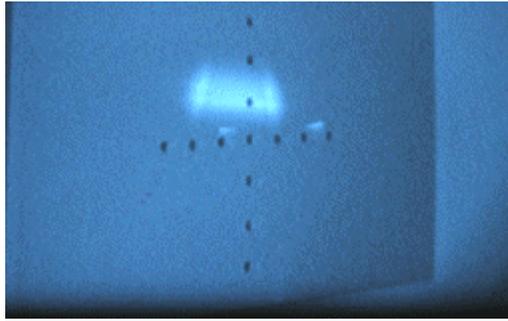
*Photos of Beam on Toroidal Mirror:



All 3 beams



"Bad" Yaw
(Note: Right shape larger than left shape)



“Good” Yaw

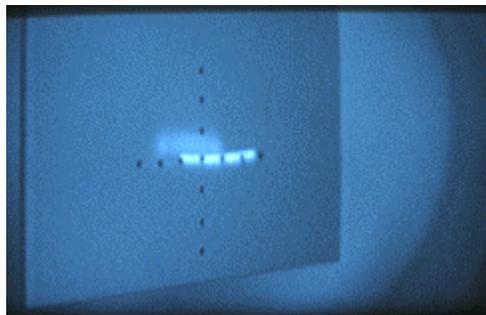
(Note: Right and left shapes are symmetrical)

*Optimized Beam Shape:

9. If the mirror is not in a good position, the shape will not be symmetric and horizontal. Yawing the mirror will adjust the horizontal orientation. Translating the mirror in the horizontal direction will adjust the symmetry. Center the Flag 5 fiducial holes on the beam (-19.15 mm). Then use a combination of these two movements to make the beam symmetrical. Raise the mirror up such that the full profile is visible².



Optimized Shape
(Ideal)



Optimized Shape
(Ideal)

² At low energies (2.5 keV), the beam may be very faint. The Mini-hutch lights can be dimmed for Flag 3 and Flag 6.

10. Go to Flag 6. The beam should be the same shape and orientation as the beam on Flag 5. Further adjust the yaw of the mirror while watching this flag (use the fiducial holes.) With the Toroidal mirror in the beam, Flag 6 should be at -89.99 mm.

II. Focusing (Second Pass):

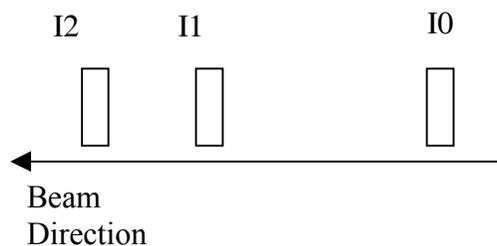
***Finding Beam in B Station:**

1. If beam is not on the EXAFS Flag, the following can be done to find the beam:
Note the present pitch angle on Tmir. Pitch up and down by approximately 1 mrad while closely watching the EXAFS Flag. The beam should flash across the screen at some point. Adjust the pitch upwards or downwards until centered on the EXAFS Flag. A common number for the EXAFS Flag to be in the beam is about 10 mm.

Under no circumstances let the beam wander off of the EXAFS flag during the aligning process. If a motion moves the beam off of the flag, undo the motion such that the beam is visible before proceeding.

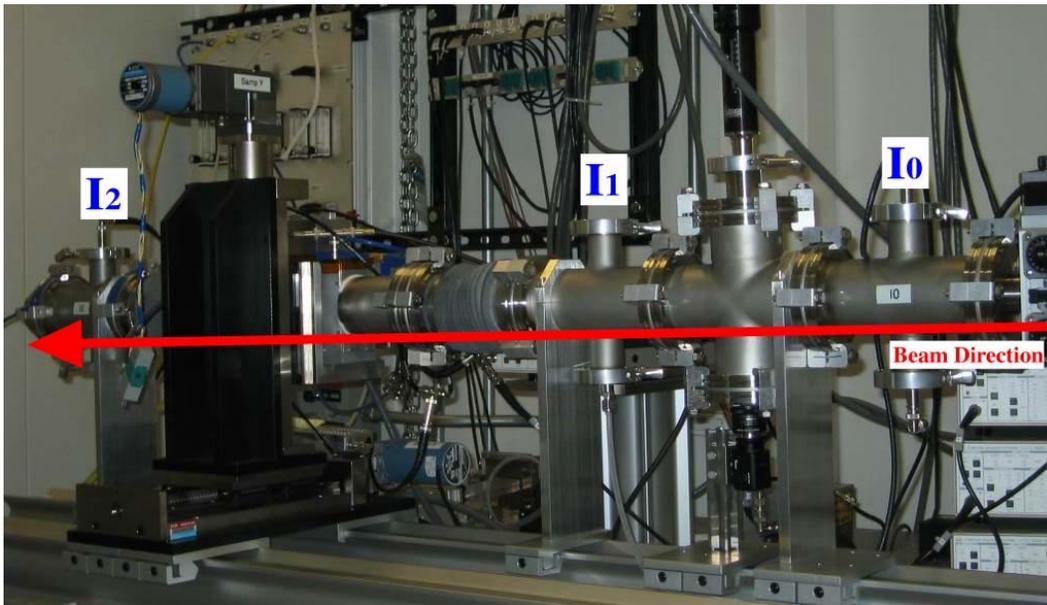
2. Determine if the Smir is in the beam or out of the beam by pitching the Tmir by approximately .005 and see in what direction the beam moves. Positive pitches on the direct beam yield upwards motion on the flag. The reflected beam will move downwards with positive pitches.
3. If the beam is not being reflected, lower Smir into the beam and lower Btable accordingly to keep the beam centered. (Perform a scan on Btable³.) Note the position of the ion chambers in 9-BM-B as below:

***Ion Chambers:**



Ion Chambers (Sketch)

³ Note that Spec does not give an average of all motors on a given component, but gives the position of **one** motor when plotting scans. The motor name is given on the plot itself.



Ion Chambers (photo)

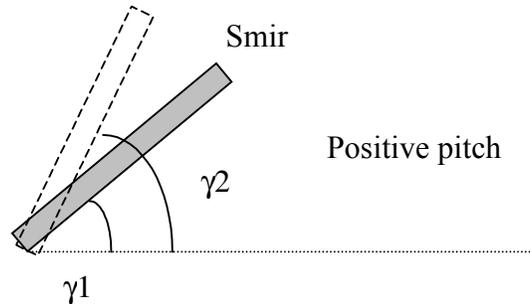
4. Consult a reflectivity curve and start pitching Smir while keeping the beam centered. Note that the intensity will drop off as harmonics are rejected.
5. Start pitching btable, translating the Btable upwards/downwards as necessary to keep the beam on the EXAFS flag.
6. Start tweaking Tmir to get the best spot size. This is a long process. The Btable pitch and Smir pitch will have to be adjusted periodically to account for the changed pitch angle on Tmir. Btable height will also have to be scanned and adjusted in order to keep the beam centered.

***Limiting Factors:**

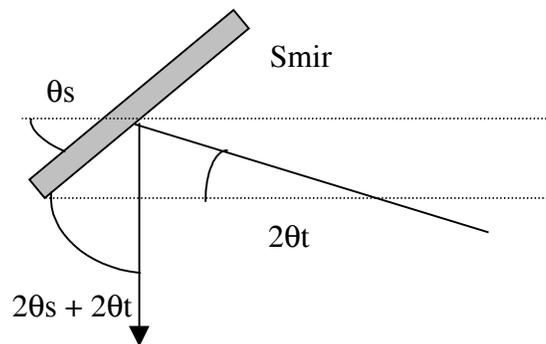
- The slit aperture is approximately 2.8 cm on each side. The flange for the slits is of diameter 3.5 cm. This is considerably smaller than the rest of the beampipe in 9-BM-B.
- Note that pitching the toroidal mirror affects both the vertical position and the horizontal size of the beam. It will be necessary to move the secondary mirror simultaneously with each pitch step in order to avoid blockage of the beam. Recommended pitch increments for the toroidal mirror is .05 mrad. If the beam disappears, the upstream flags should be checked to ensure that one of them is not blocking the beam. (The most likely candidate for this is Flag 6 at high pitch angles.)

***Note about pitching the Secondary Mirror (Smir):**

Keep in mind that the Smir reflectivity drops dramatically at increasing angles. When it becomes necessary to pitch Smir, then then a reflectivity curve for the appropriate energy must be consulted in order to preserve flux. The convention for the secondary mirror is that a positive pitch corresponds to the upstream end of the mirror being higher than the downstream end.



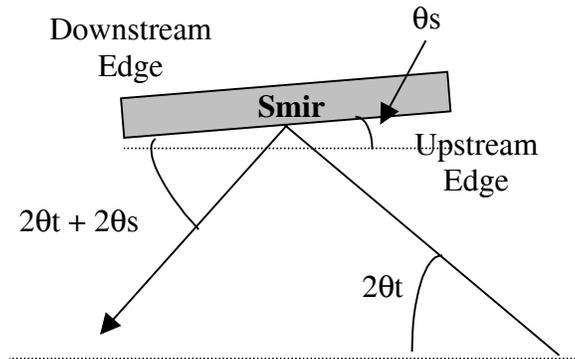
According to the software, the secondary mirror is pitched according to position with respect to the horizontal. However, it should be kept in mind that the toroidal mirror will also have a pitch angle of its own.



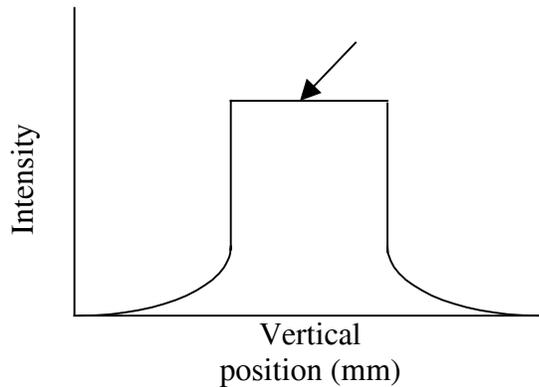
Therefore,

(desired Smir pitch) - $2\theta_t$ = amount by which to *actually* pitch smir.

***Centering beam on Smir (Vertically):**



1. Lower mirror until the reflected beam just disappears (upstream edge found.) Note vertical position.
2. Raise mirror until reflection disappears (downstream edge found.) Note vertical position.
3. Take the difference and lower Smir by 1/2 of that amount.
4. Perform a vertical mirror scan and position the mirror accordingly (see below). This scan may have to be performed a few times.

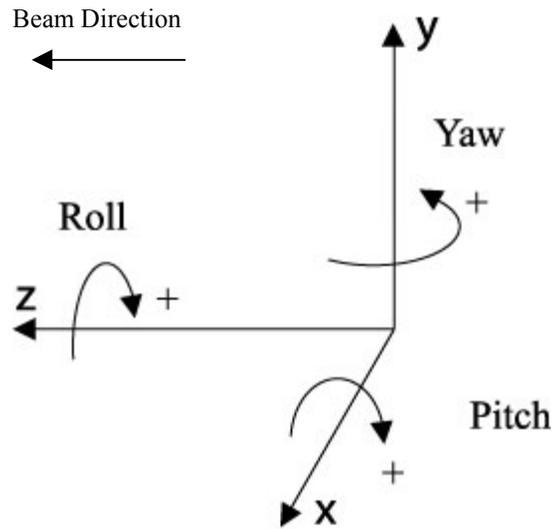


***Note about pitching the toroidal mirror:**

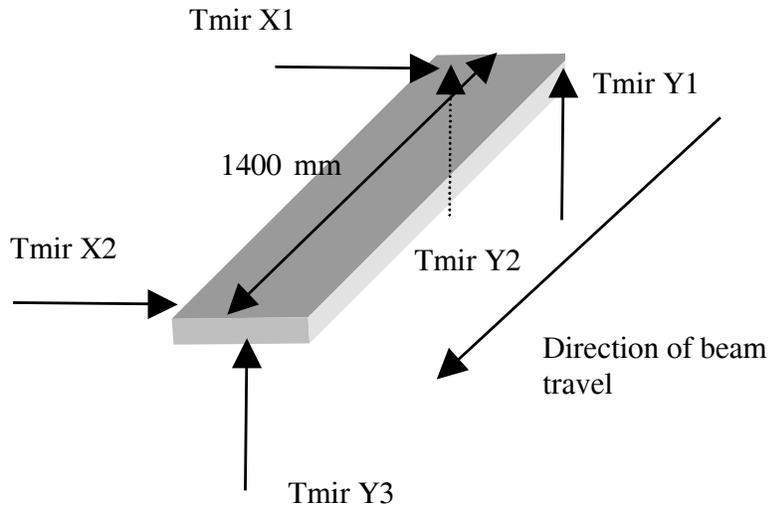
Before and beyond the best horizontal focus, the direct beam will broaden and change orientation. This seems to be due to the shift in focal point for the nearly-central radiation reflected from the mirror. Before the focal point, the beam is wide and curved upwards (a smile.) At points close to the focal point, the beam is approximately circular. Beyond the focal point, the beam is oriented in the opposite direction (a frown.)

A beam that is close to being focused will change smoothly with variations in parameters such as pitch. It also will not move with modest changes in energy (a few keV up and down.)

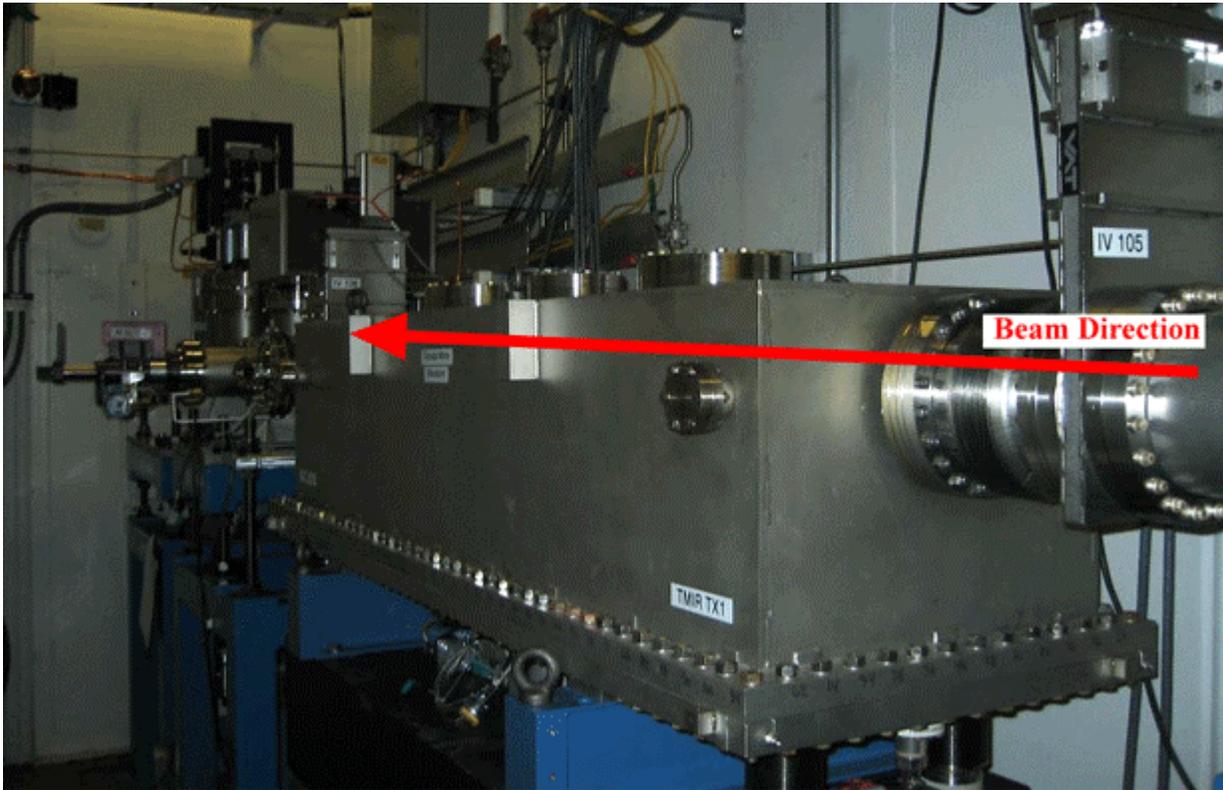
***Toroidal Mirror Conventions:**



Toroidal Mirror Angular Movement

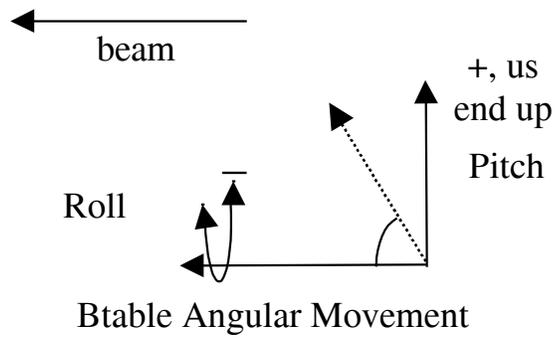


Toroidal Mirror Motor Positions



Toroidal Mirror Photo

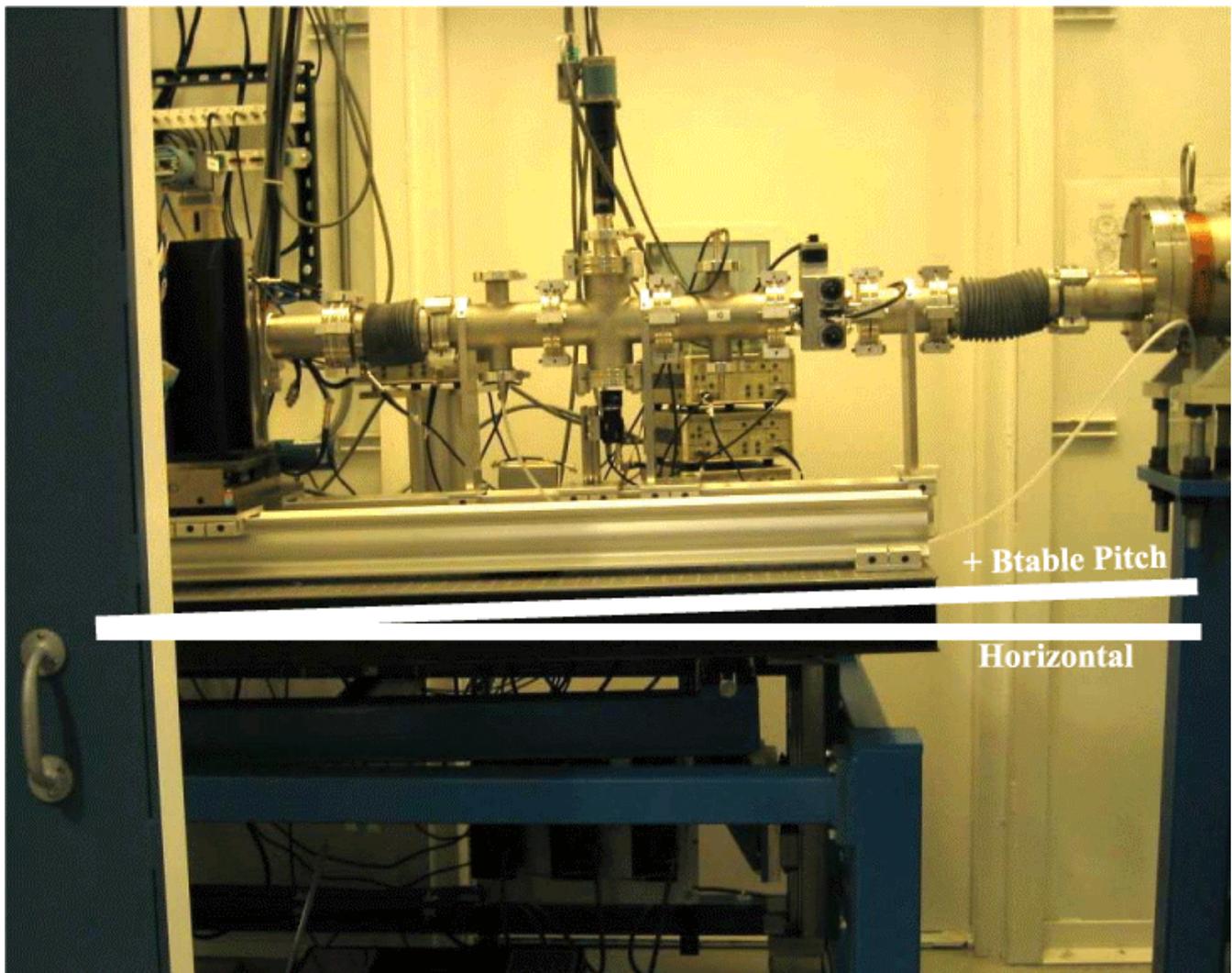
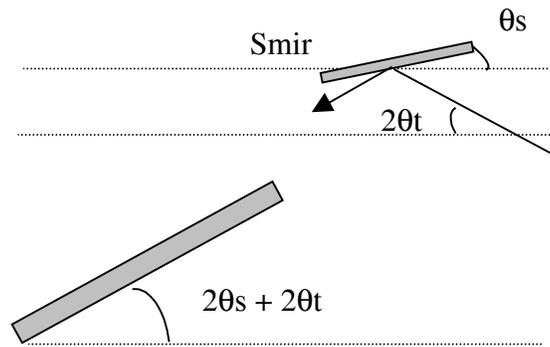
***Btable Movement:**



*Btable Pitch:

If it desired that the B-station table (Btable) be exactly aligned such that the beam travels down the center of the flight path mounted on it:

- 1) **Desired pitch = $+(2\theta_s + 2\theta_t)$**

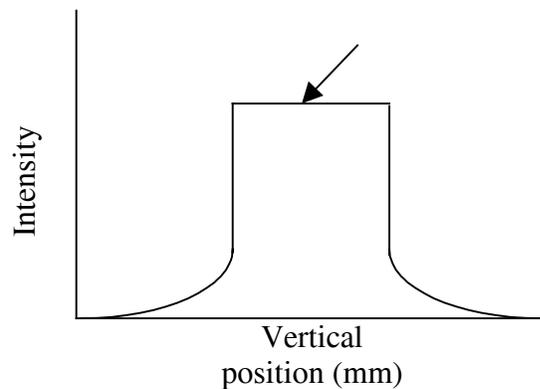


Btable with pitch

III. Focusing (Third Pass):

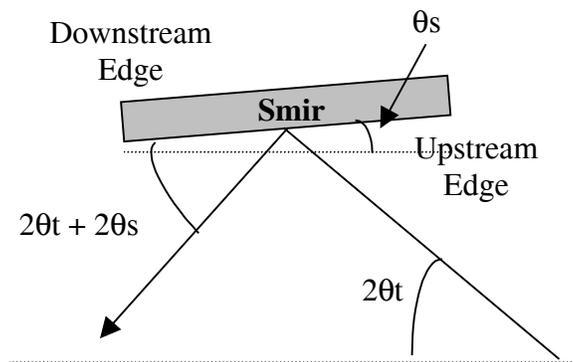
After the beam has been visually optimized on the EXAFS Flag, ion chambers should be used to quantify and maximize the intensity. Since scans were used in the second pass, final positions for Smir and Btable should not be far off. Check to make sure that the pitch angles for each of these components are correct, especially Smir.

1. Change energy by 1 keV in each direction to check for beam motion.
2. Close the vertical White Beam Slits to approximately .3 mm. Scan the vertical slit center in order to adjust for intensity¹. The scan should be -1mm to + 1 mm (30 steps should be fine.) **Do not** adjust the horizontal slit center, but the horizontal slits may be opened up for increased flux during the scans. A horizontal opening of 20 mm is appropriate. Once the vertical center position is adjusted, open the vertical slits back up to the original width.
3. Scan Tmir vertically and find the best intensity⁴. The pitch angle may have to be tweaked after this is done. Tweaking should be done in .01 mrad steps, if not smaller. Look at the beam visually on the EXAFS Flag in order to do this.

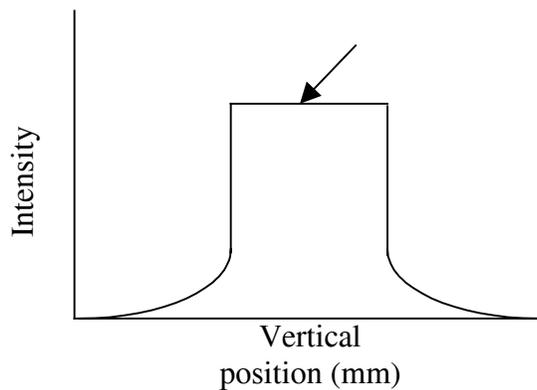


⁴ Note that Spec does not give an average of all motors on a given component, but gives the position of **one** motor when plotting scans. The motor name is given on the plot itself.

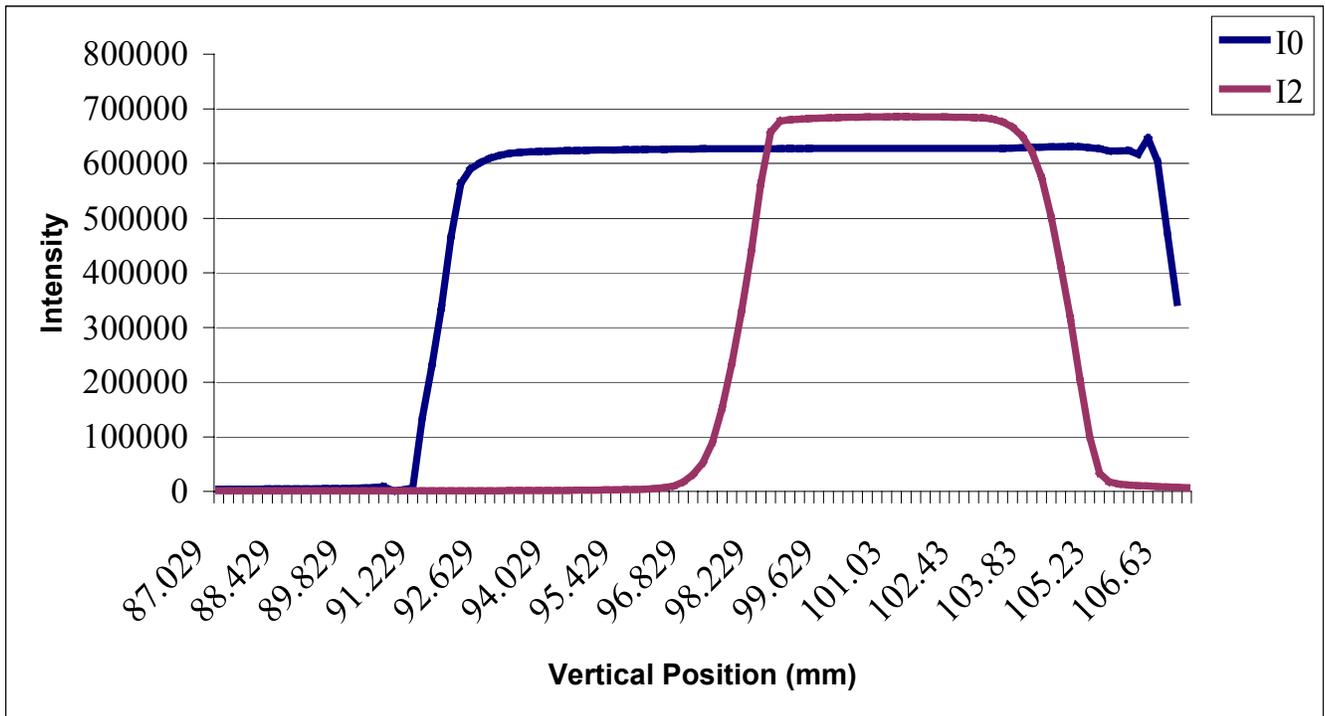
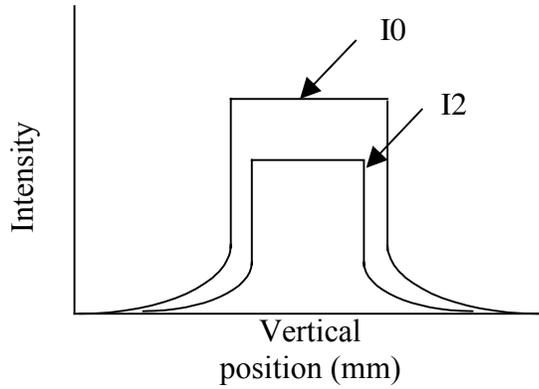
7. Center the beam vertically on Smir and optimize for intensity:



- 7a. Lower mirror until the reflected beam just disappears (upstream edge found.) Note vertical position.
- 7b. Raise mirror until reflection disappears (downstream edge found.) Note vertical position.
- 7c. Take the difference and lower Smir by 1/2 of that amount.
- 7d. Perform a vertical scan and position the mirror accordingly (see below). This scan may have to be performed a few times.



4. Perform a fine scan on Btable and optimize for intensity. The table may have to be pitched and adjusted slightly for height after this is done in order to optimize intensity in I2. The vertical table position should be approximately 159 mm, with a pitch of -11.9 mrad. Qualitatively, table scans of I0 and I2 should show the following:

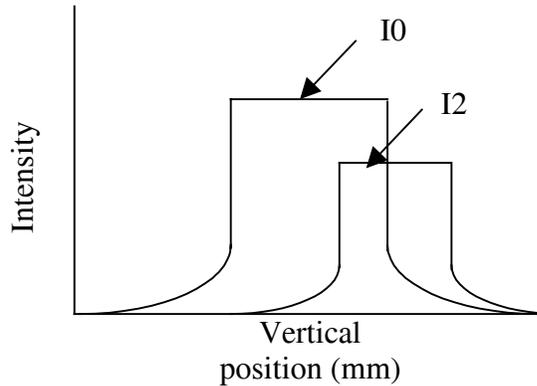


(Note: In this case, Ion chambers are slightly off-center.)

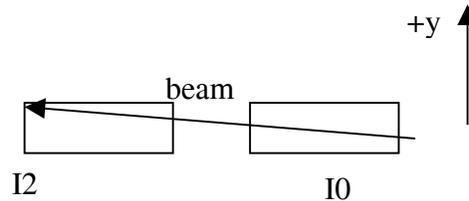
The ending ion chamber measurements were comparable.

***Ion Chamber Positioning:**

One can use the btable scans to determine how well ion chambers are lined up. For example, a scan such as



can indicate that the beam is at an angle with respect to the chambers. In this case, I2 is too low; the btable should be pitched positive (front end downwards.)



IV. Alternative method for third pass focusing:

Instead of looking at the ion chambers right away, it is also possible to use the EXAFS flag to keep the beam near to the center of the ion chambers while smir and btable are being pitched to the desired angles.

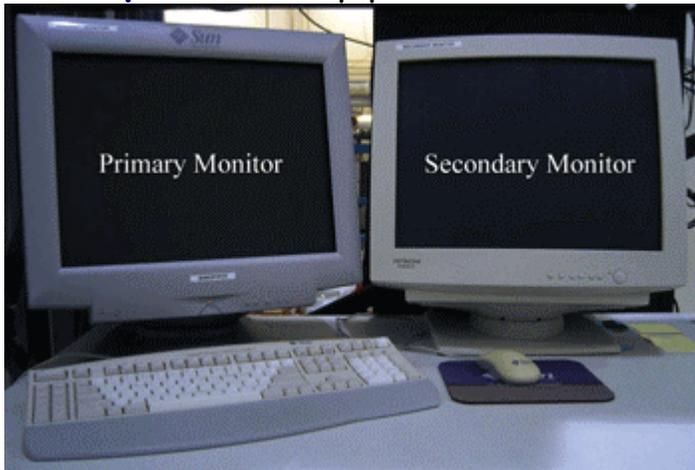
1. Lower EXAFS flag into the beam such that it is in the central region of the flag.
2. Note position.
3. Pitch smir to the desired position in steps of approximately 1 to 3 mrad. As the beam is deflected downwards, translate btable vertically as needed to keep the beam in approximately the same position on the flag.
4. Start pitching btable according to 1.) This should be done in 1 to 3 mrad steps. As the table is pitched, it should also be lowered in appropriate increments to keep the beam in roughly the same position on the flag. The ion chambers should be

checked as this is done to ensure some flux is preserved in them as the table is pitched.

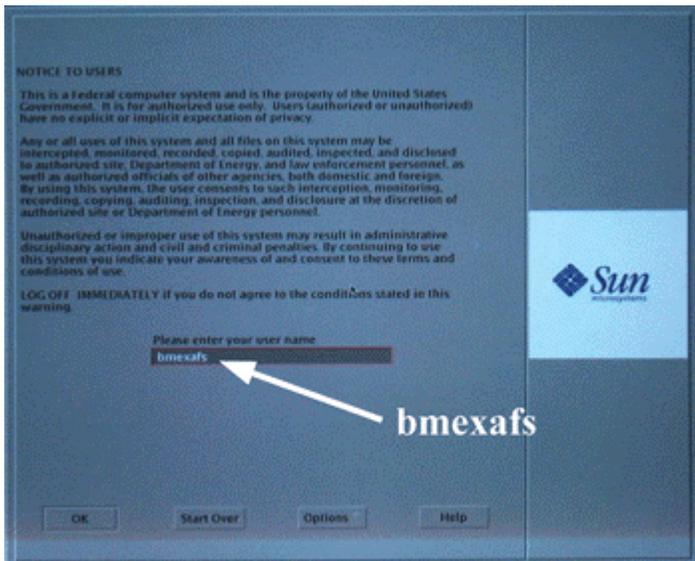
5. Do a vertical scan on btable (-15, 15, 40, 1). Position in center of plateau for I0.
6. Look at I2's intensity for the same scan. If the position is not centered on I0's plot, move the Y2 and Y3 motors up or down as appropriate, until the ion chamber is centered.

V. 9-BM Operations Cheat Sheet:

- **Computer:** Sandpiper



- **User name:** bmexafs



- **Password:** ask beamline staff
- **Printer name on beamline:** killdeer
- **Twth:** tweaks theta to get more intensity

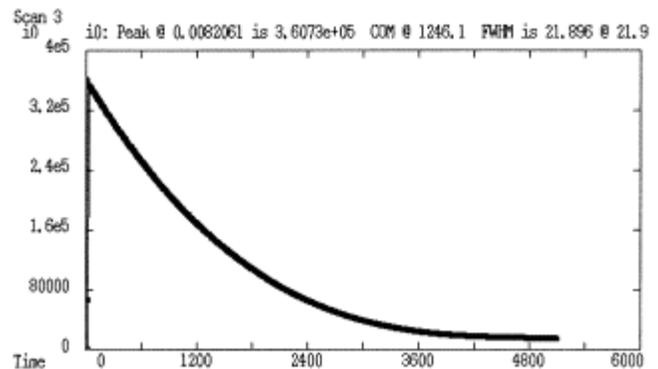
➤ **Running a macro:** "qdo <filename>"

➤ **Plotting in SPEC** - SPEC will plot curves for different ion chambers as desired. To change the default displayed on screen:
plotselect <ion chamber name>

Example:

Plotselect i0

(Default Ion Chamber
Plotted is i0)

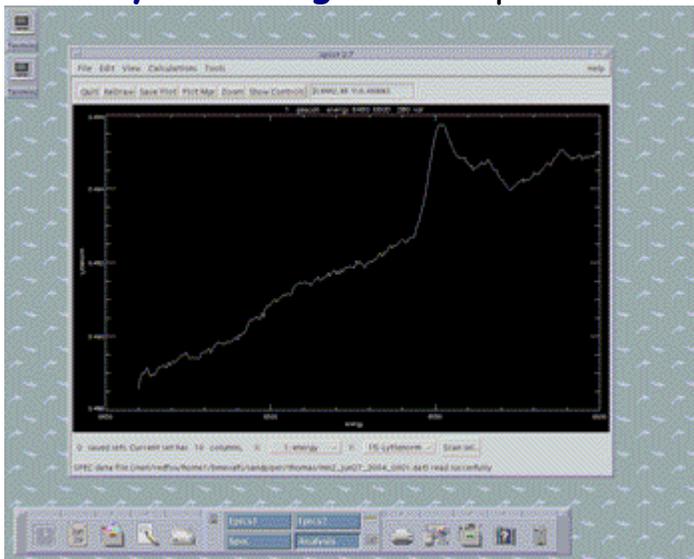


➤ **To see a plot of another ion chamber for the same scan (default not changed):**

Splot <ion chamber name>

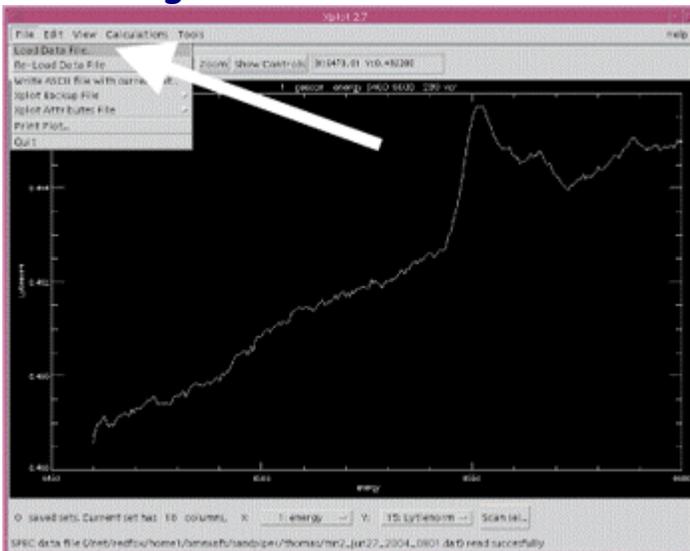
➤ **Printing a SPEC Plot:** FOURC>xdump

➤ **Analysis Package: XOP Xplot**



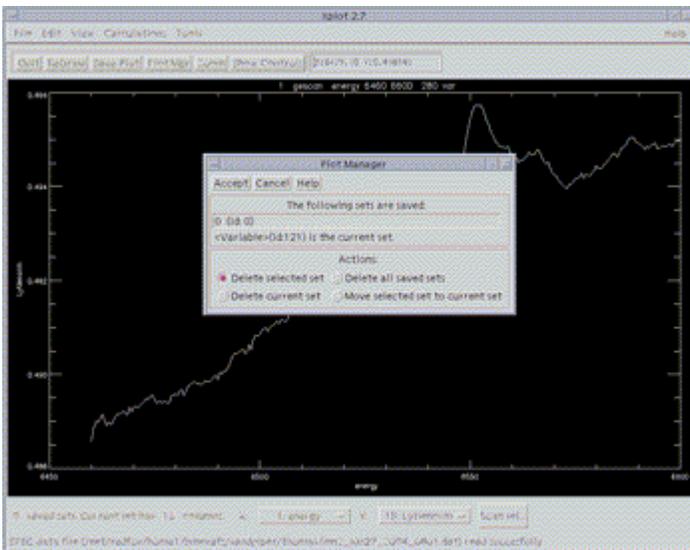
➤ **Starting the analysis package:** In a terminal window, type "xop xplot".

- **Plotting data:** File→load data file→filename



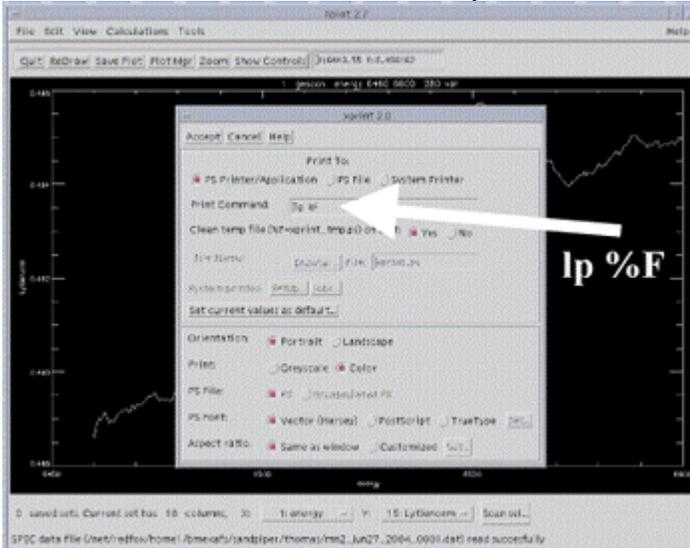
- **Plotting two or more sets of data simultaneously:** load a scan, hit "save plot" after each set is plotted. Keep track of the x- and y- scales when doing this; the scale is chosen automatically for the most recently-loaded set.

- **To clear the saved data sets:** Plotmgr→select set(s) to be cleared.



- **Changing the x- and y- scales:** Edit→set→limits and styles

- **Printing Plots:** make sure that "lp %F" and *NOTHING* else is in the print window (the default is "lp -d %F".)



VI. Why am I not Getting Beam?

Common Reasons:

1. Has the gas ran out (or is not on) for one of the detectors or on the rest of the experimental set-up in 9-BM-B? (Check both bubble bottles. If one or both is not bubbling, and the gas is not out or turned off at the tanks, adjust the flow on the panel inside 9-BM-B.)
2. Has the beam moved since the last beam dump? The most common fix for this is to translate Tmir by a few mm. Use EXAFS flag to visually evaluate where the beam is.
3. Is the shutter open? (Don't laugh.)
4. Is a flag blocking the beam?