

9-BM Alignment Procedure

July, 2005

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9-BM Alignment Procedure

July, 2005

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.¹
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.

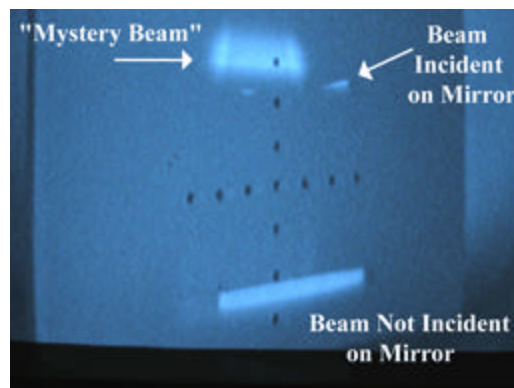
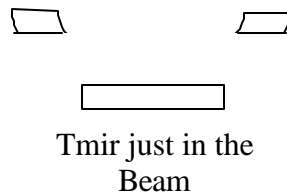
Otherwise:

4. Next, go to Flag 3. There should be two distinct beams present at lower energies (~5 keV)
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.

¹ Go to page 23 of lab book #2 if the inchworm motor has been turned off.

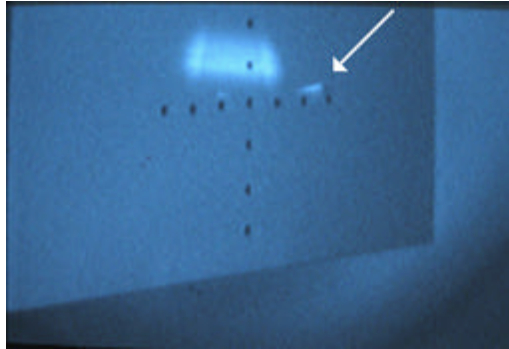
7. Change energy (decrease) by approximately 5 keV, while watching the beam position. The intensity distribution and position should not change with changing energy. The vertical position of the horizontal holes on Flag 5 should be -54.5 mm^2 . If the beam intensity drops off, tweak θ to increase again.
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 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:



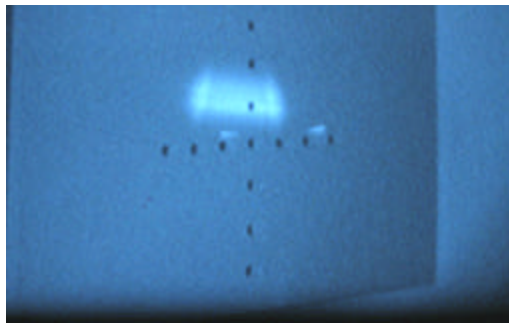
All 3 beams

² 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.



“Bad” Yaw

(Note: Right shape larger than left shape)



“Good” Yaw

(Note: Right and left shapes are symmetrical)

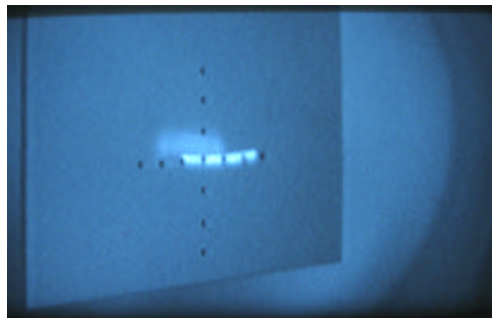
*Optimized Beam Shape:

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 visible³.

³ 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.



Optimized Shape
(Ideal)



Optimized Shape
(Ideal)

10. Go to Flag 6. The beam should be the same shape and orientation as the beam on Flag5. 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):

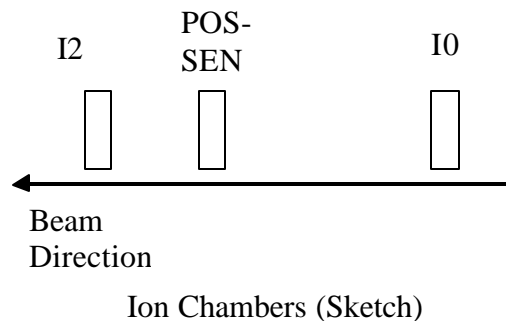
***Finding Beam in B Station:**

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. Check to make sure that the bslits are open vertically and horizontally.

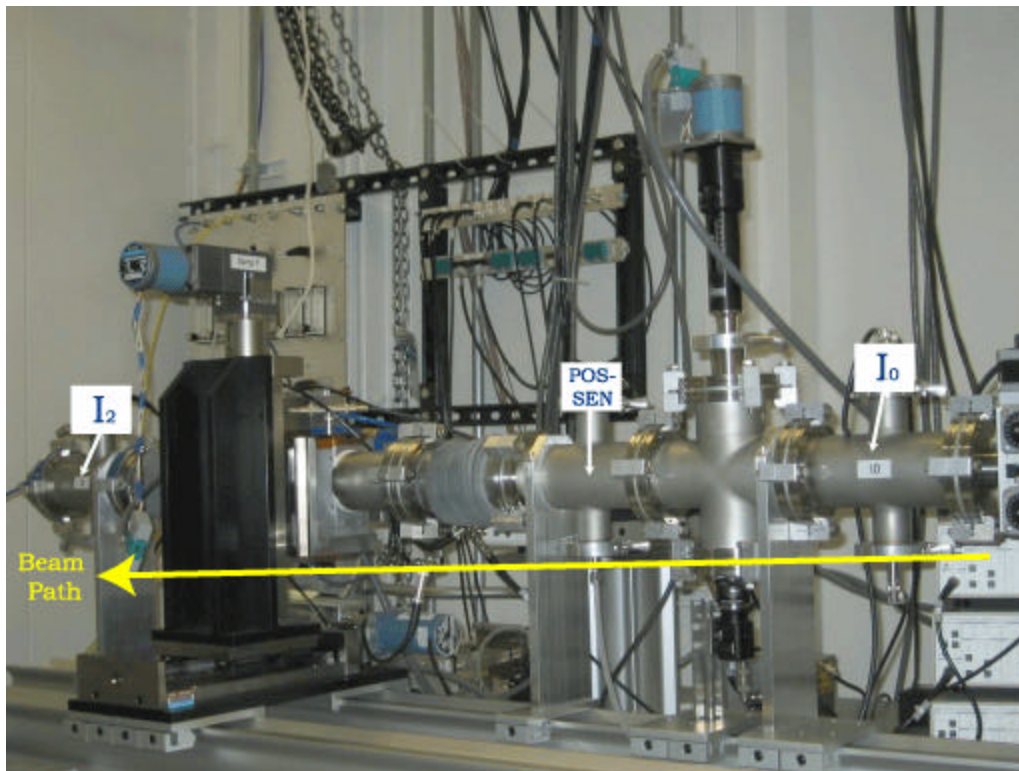
Under no circumstances let the beam wander off of the EXAFS flag during the aligning process. If a motion moves the beam off of the flag, undo the motion such that the beam is visible before proceeding.

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 Btable⁴.) Note the position of the ion chambers in 9-BM-B as below:

***Ion Chambers:**



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.



Ion Chambers (photo)

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

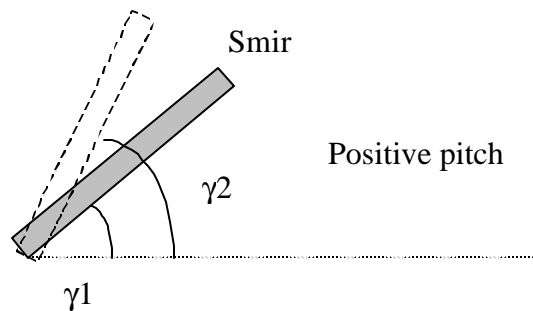
*Limiting Factors:

- 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

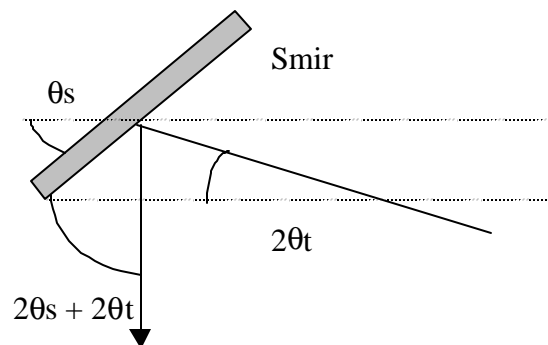
flags should be checked to ensure that one of them is not blocking the beam. (The most likely candidate for this is Flag 6 at high pitch angles.)

***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 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.



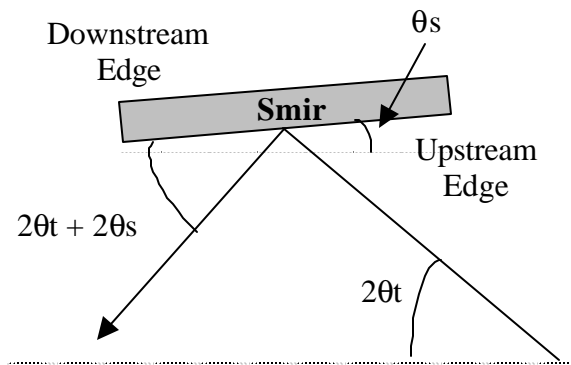
According to the software, the secondary mirror is pitched according to position with respect to the horizontal. However, it should be kept in mind that the toroidal mirror will also have a pitch angle of its own.



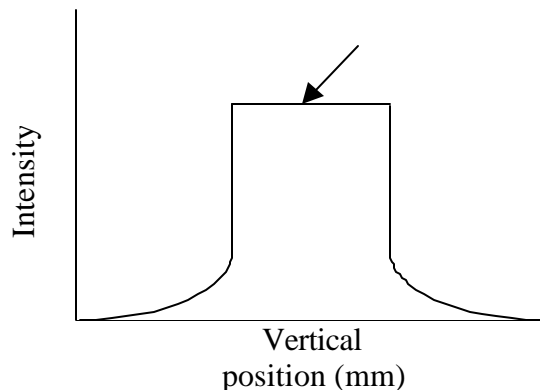
Therefore,

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

*Centering beam on Smir (Vertically):



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

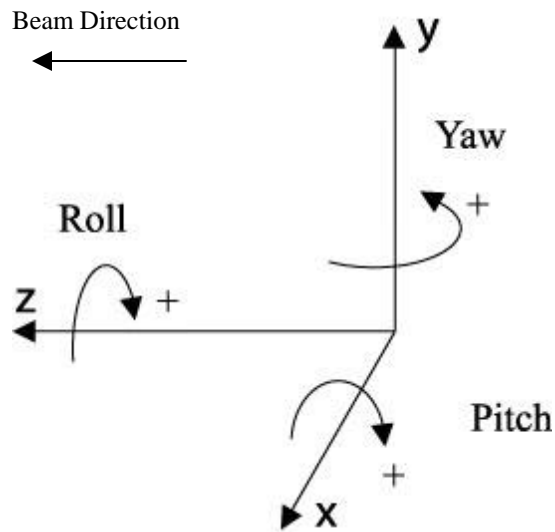


*Note about pitching the toroidal mirror:

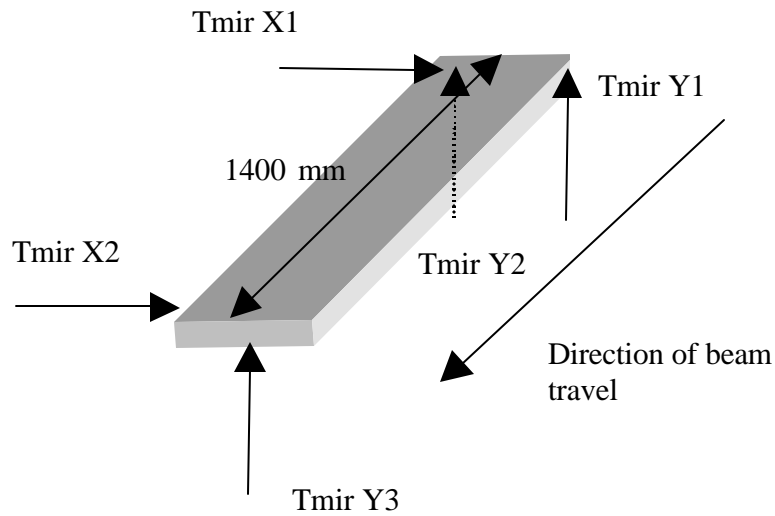
Before and beyond the best horizontal focus, the direct beam will broaden and change orientation. This seems to be due to the shift in focal point for the nearly-central radiation reflected from the mirror. Before the focal point, the beam is wide and curved upwards (a smile.) At points close to the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

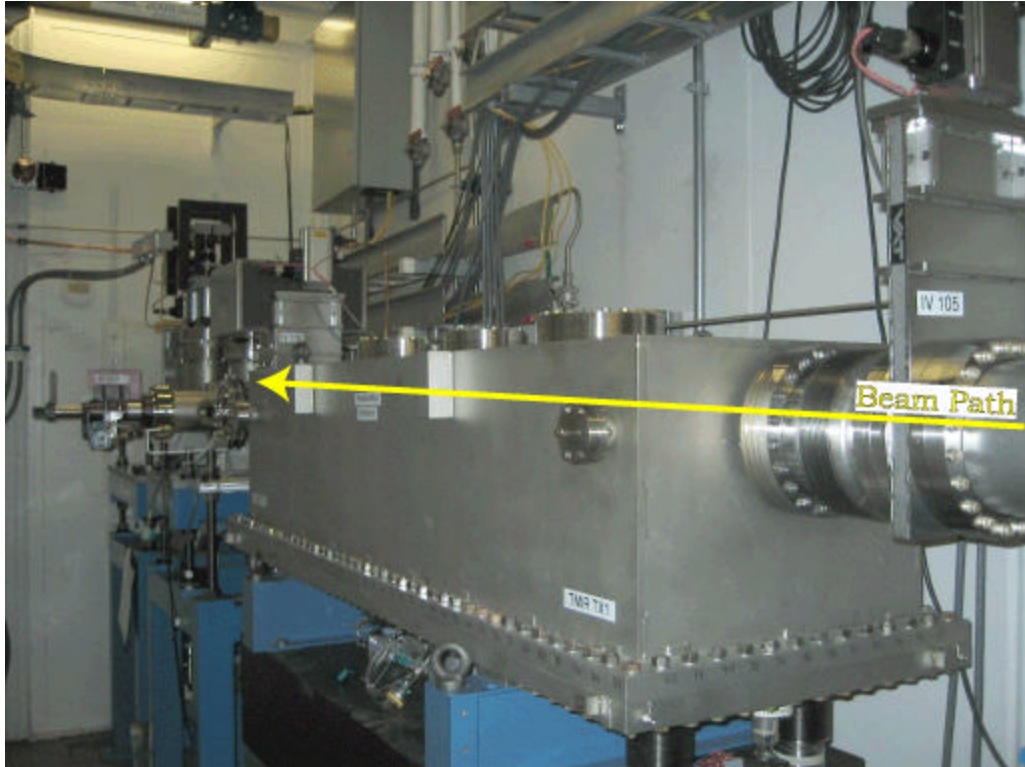
***Toroidal Mirror Conventions:**



Toroidal Mirror Angular Movement

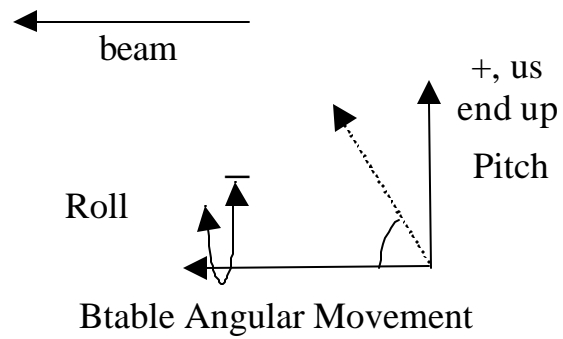


Toroidal Mirror Motor Positions



Toroidal Mirror Photo

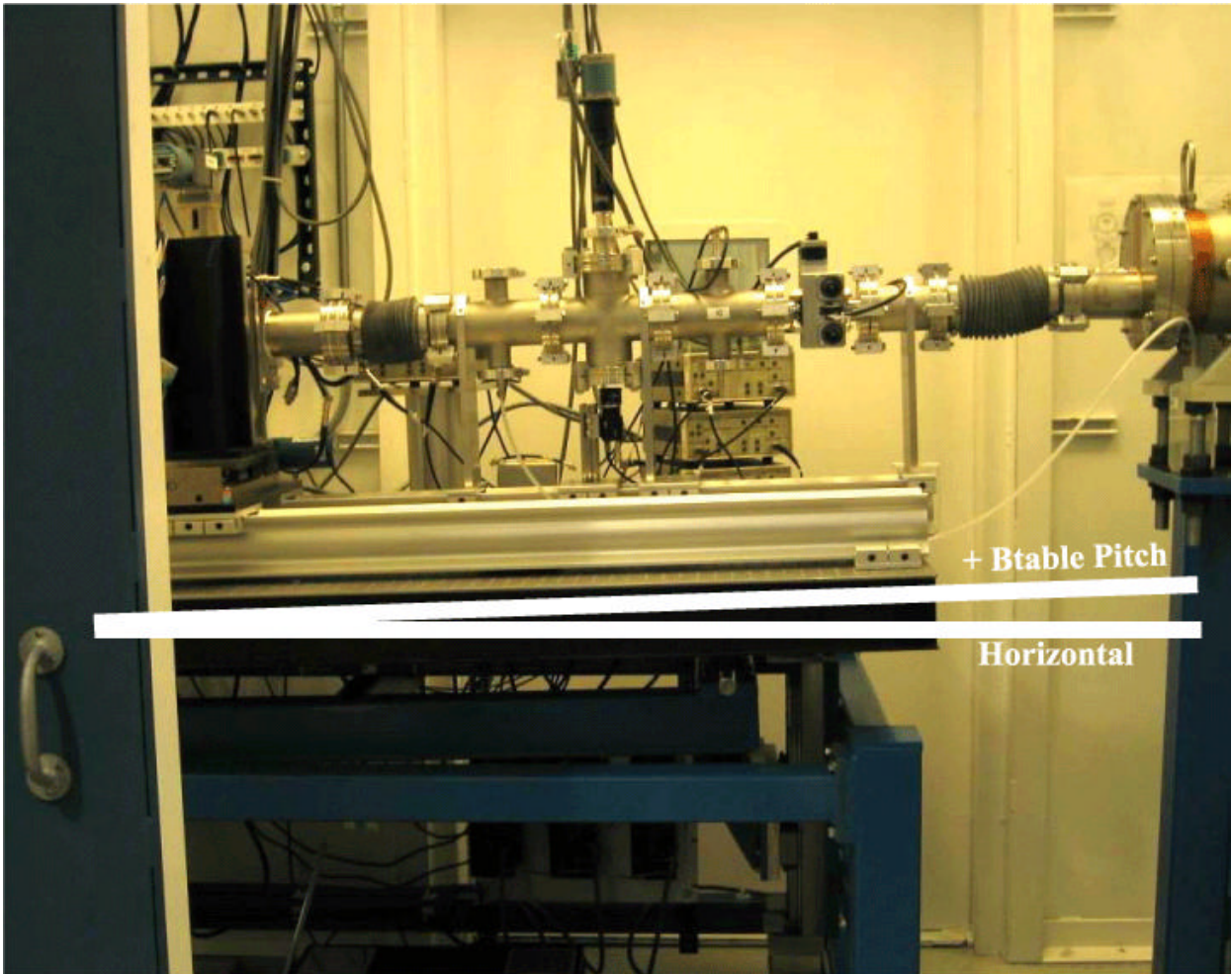
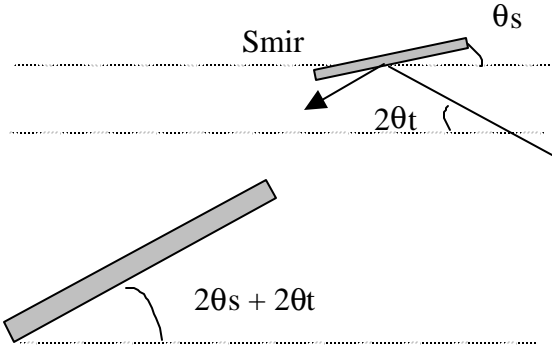
***Btable Movement:**



***Btable Pitch:**

If it is 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:

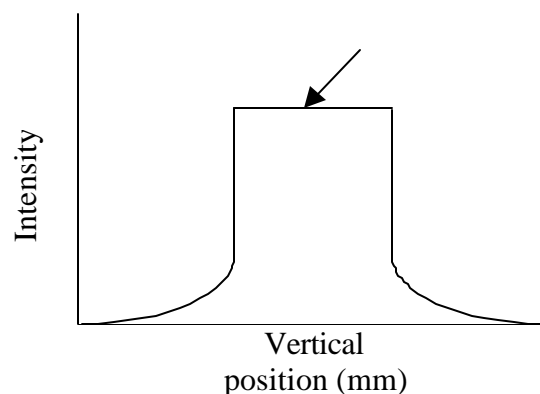
1) **Desired pitch = $+(2qs + 2qt)$**



III. Focusing (Third Pass):

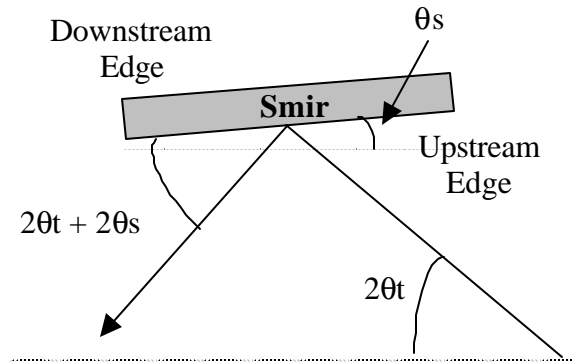
After the beam has been visually optimized on the EXAFS Flag, ion chambers should be used to quantify and maximize the intensity. Since scans were used in the second pass, final positions for Smir and Btable should not be far off. Check to make sure that the pitch angles for each of these components 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 intensity⁵. 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.

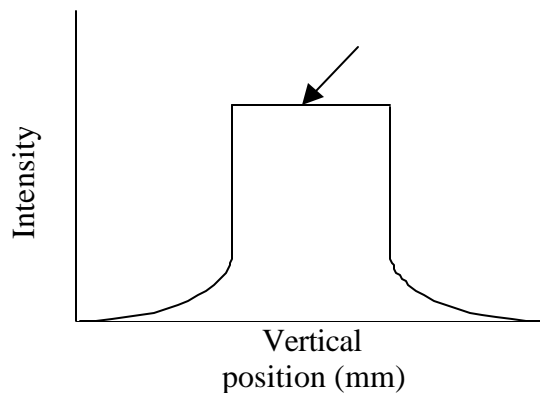


⁵ Note that Spec does not give an average of all motors on a given component, but gives the position of **one** motor when plotting scans. The motor name is given on the plot itself.

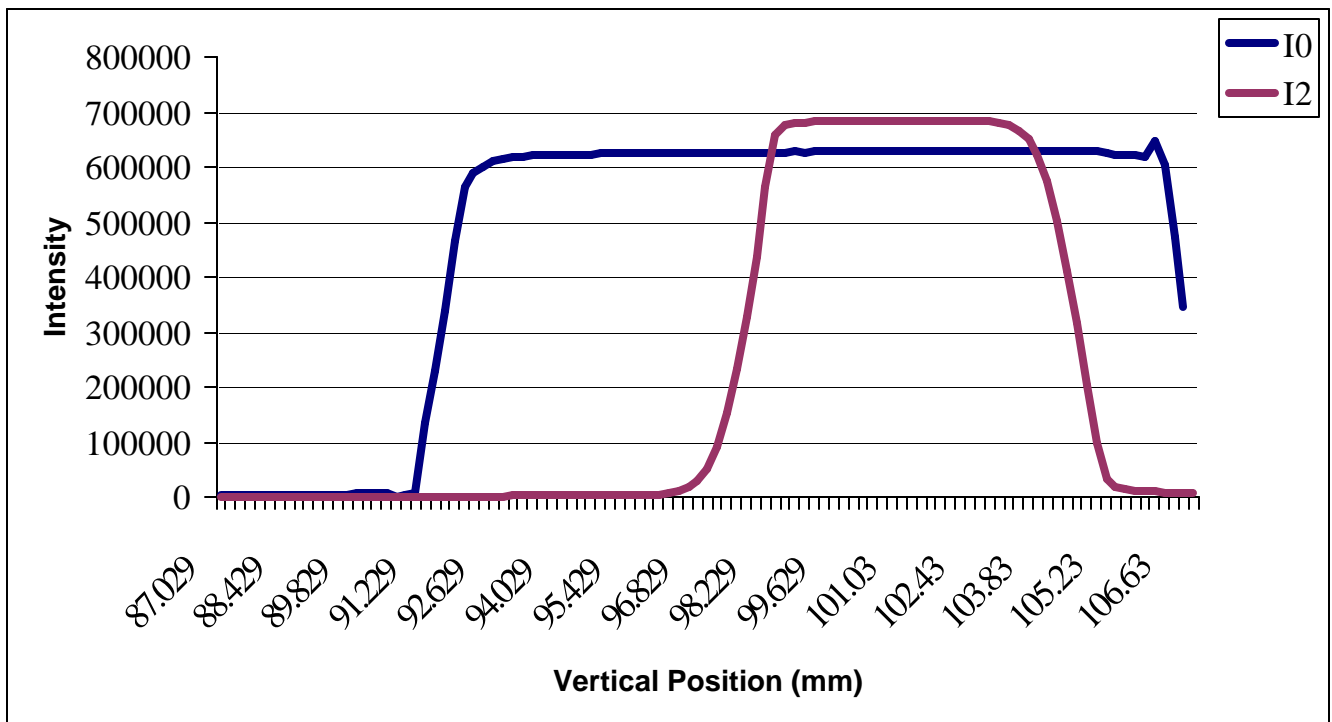
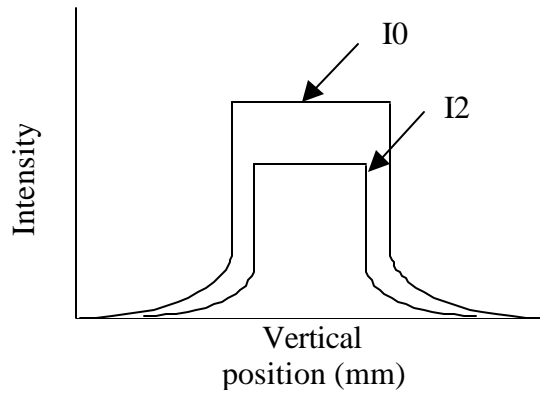
4. Center the beam vertically on Smir and optimize for intensity:



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



5. 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:

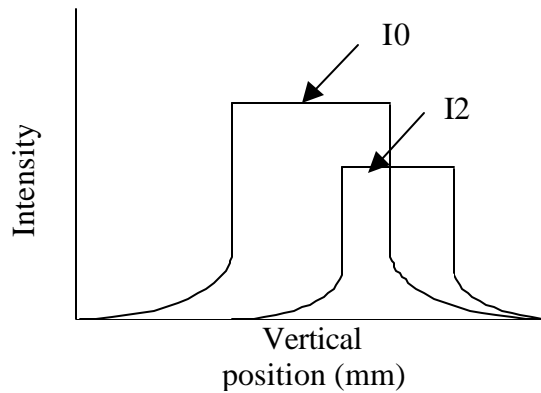


(Note: In this case, Ion chambers are slightly off-center.)

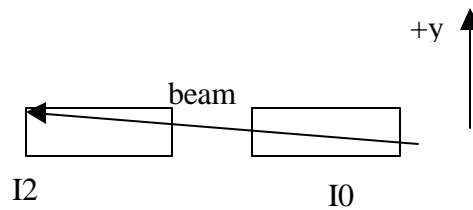
The ending ion chamber measurements were comparable.

*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:

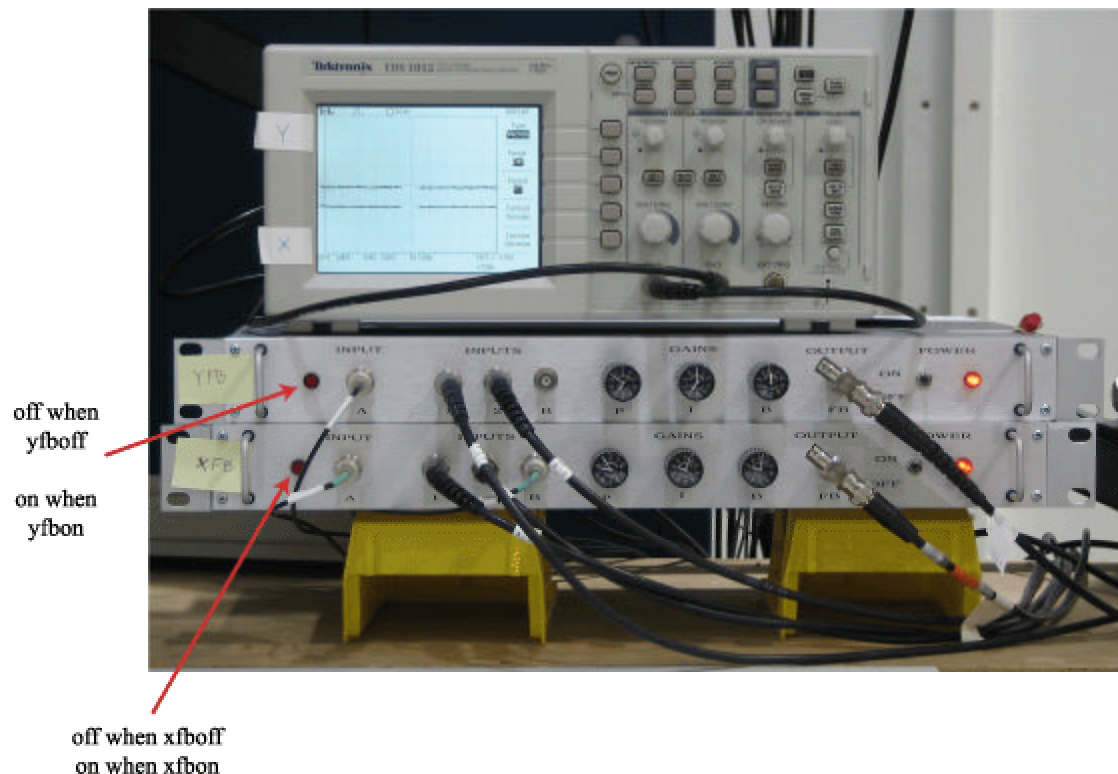
Instead of looking at the ion chambers right away, it is also possible to use the EXAFS flag to keep the beam near to the center of the ion chambers while smir and btable are being pitched to the desired angles.

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. Closing the B-slits onto the beam:

1. Lower EXAFS flag into the beam.
2. Close slits and move bslit vertical and/or horizontal center in steps until desired aperture is achieved.

VI. FeedBack System (Horizontal and Vertical):



Above: Photo of Feedback System
(Located at 9-BM B Work Area)

xfbmode ---prepares everything for turning feedback on
chimode⁶ ---enables one to tweak chi while in xfbmode
xfbon⁷ -----close relay for horizontal feedback system
xfboff -----open relay system for horizontal feedback

⁶ When in xfbmode, DO NOT twchi w/o issuing chimode command first.

⁷ One may be in xfbmode but not quite ready to close the relay (xfbon). One can re-align, etc., with the inchworm motor engaged and ready, before typing xfbon.

yfbon⁸ ----turns on vertical feedback system
yfboff----turns off vertical feedback system

***Changing energies with feedback:**

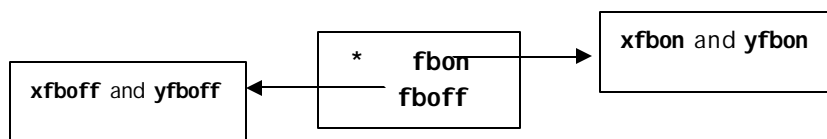
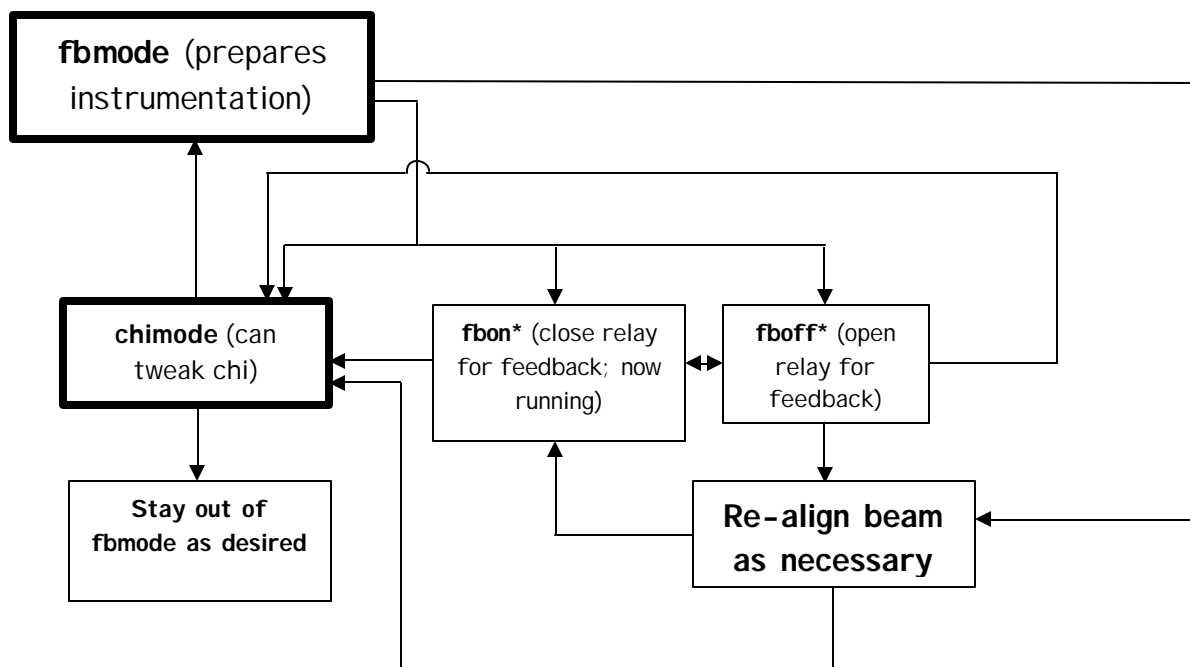
1. fboff
2. Change energy
3. IY1, IY2, IX1, and IX2 should not change too much (keep within range where feedback can work properly.) See Ip330Scan.adl.

Note: the input signal to the feedback system is divided by the i0 reading; the gain should not change.

Periodically, the feedback should be turned off (especially for the horizontal direction) and the raw signals in the pos-sen ion chamber should be looked at. If they are not roughly equal, the feedback system may be out of range and not able to work properly. Tweak the btable position and then turn on the feedback again.

Alternatively, Y/100 and X/100 should be in the mid-range region (0.5 for Y/100 and 3 for X/100.) If they are not, then tweak the table position.

***Allowed Paths:**



YFB at 5V, vertical feedback loop is **closed** (FET switches.)
 YFB at 0V, loop is **open**.
 XFB at 5V, horizontal feedback loop is **closed**.
 XFB at 0V, loop is **open**.

***Alignment with the Feedback System in place:**

-When scanning beamline components, such as the btable, turn the system off.

Note: when turning the horizontal feedback system back on, the reset button on the Burleigh power supply may have to be hit.

Note: there are two lights on the vertical system power supply; one to indicate that the beamline is in chimode and one for fbmode. Only one or the other of these lights should be on at any given time. If both lights are on, there is a problem with how commands are being physically issued to the fb system. Call beamline staff. The system is designed such that the beamline cannot actually be in both states at the same time.

***How to use the oscilloscope to diagnose common mistakes:**

1. If the signal on the oscilloscope goes all the way to one position or another, with no oscillatory behavior, then the wires have been wrongly connected on the position-sensitive ion chamber. (There are two sets of wires; one for the vertical plates, and another for the horizontal plates.)
2. If the signal starts to oscillate, then the gain is turned up too high (the system is over-compensating.) Reduce the gain and try again.
3. If the signal disappears off the screen the btable is not positioned properly. Turn the feedback off and re-position the btable.

***If there is initially no oscillatory motion, but when the system is turned off and then on, with oscillatory motion occurring after that point, the gain is too high. Reduce the gain and try again.**

*How to run a scan with the feedback system in place:

1. fboff
2. look at the top, bottom, inboard, and outboard signals on the Ip330Scan.adl screen.
3. if the two vertical readings are not roughly equal and/or the two horizontal readings are not roughly equal, then move btable accordingly:

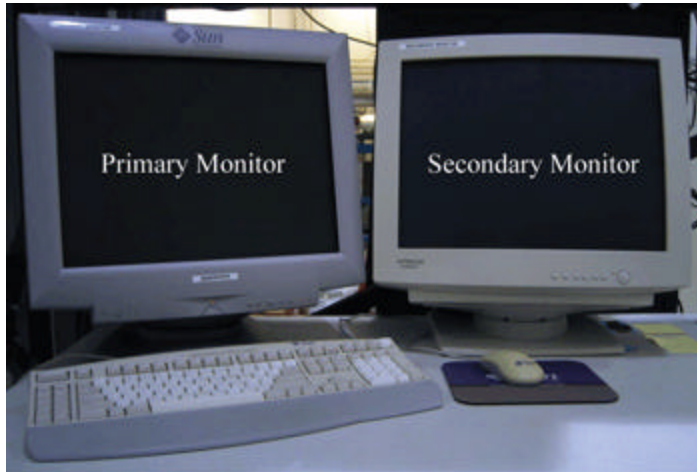
btabley <number> moves the table in the vertical direction (“+” is up, “-” is down)

btablex <number> moves the table in the horizontal direction (“+” is outboard, “-” is inboard)

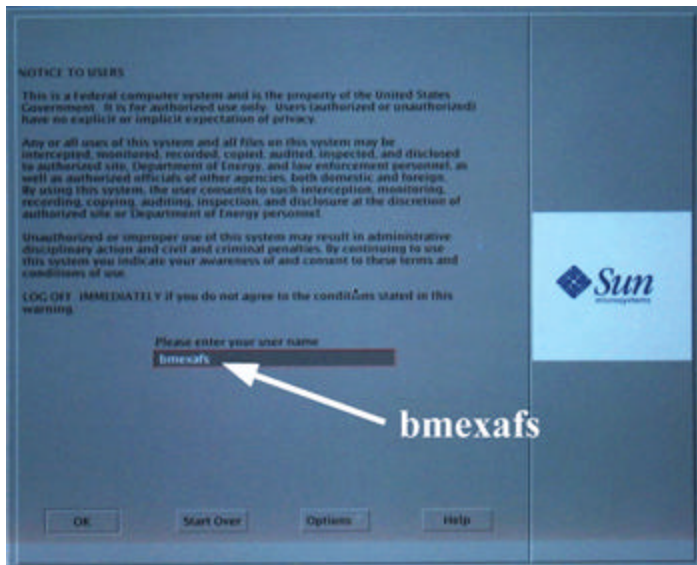
4. fbon
5. samplescan <regionfilenamewithoutextension>

VII. 9-BM Primary Computer Cheat Sheet:

- **Computer:** Sandpiper

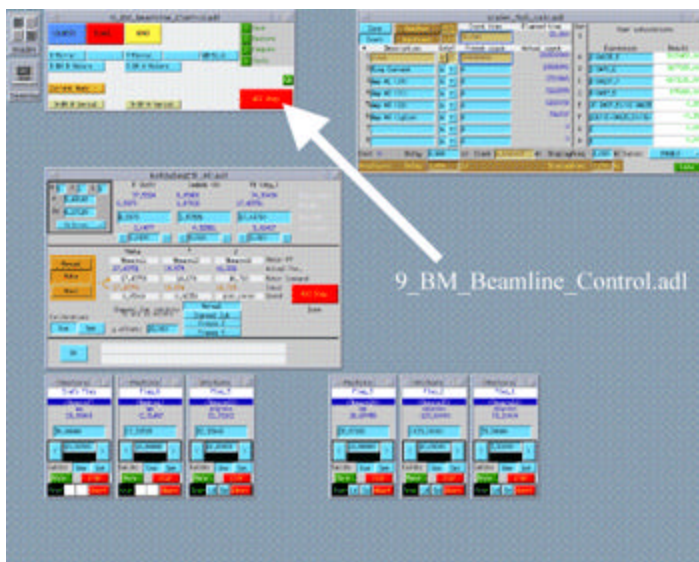


- **User name:** bmexafs



- **Password:** ask beamline staff
- **Printer name on beamline:** killdeer

- **Twth:** tweaks theta to get more intensity



- **Starting EPICS:** On the secondary monitor there is a terminal set up. (If there is not a terminal, right-click the mouse and choose from the menu.) Type "bmepics". The most relevant windows open up automatically. Other windows can be accessed from the

menu, which also appears. It is named "BM_Beamline_Control.adl".

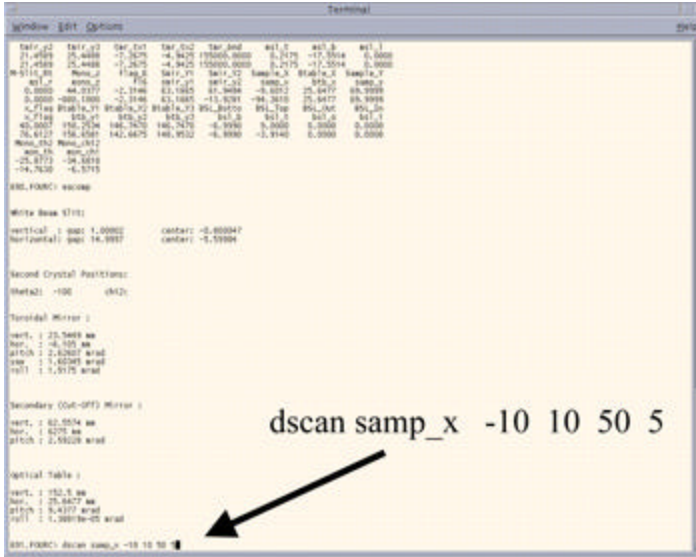
- **Starting EPICS with ONLY the "BM_Beamline_Control.adl" window showing:** "abmepics".

- **Automatic Front End Shutter operation:** Open a terminal window and at the prompt type "9BMFEPS".

- **Starting SPEC:** On the primary monitor, in a terminal window, go to your directory, then type, "fourc". To get help in SPEC, type "help".

- **Running an EXAFS scan:** Make sure you are in your directory ("pwd"). Type "samplescan <filename>". The file name must end in

“.rgn”, but this extension is *NOT* included when typing in the filename.



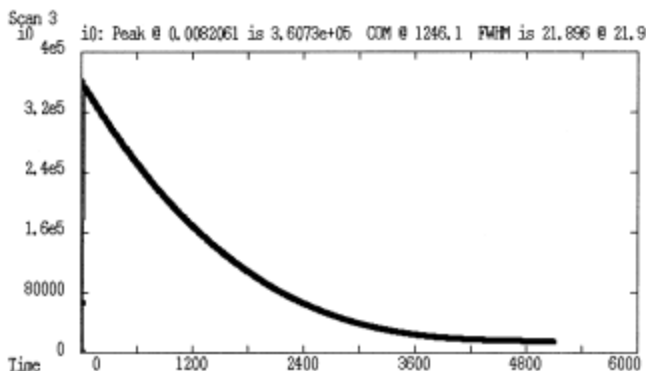
- Scanning other motors: dscan motorname startposition endposition numberintervals timeateachpoint

Example:

dscan samp_x -10 10 50 5

(This is a relative scan. Motors are returned to the original positions.)

- Loading a macro: "qdo <filename>"



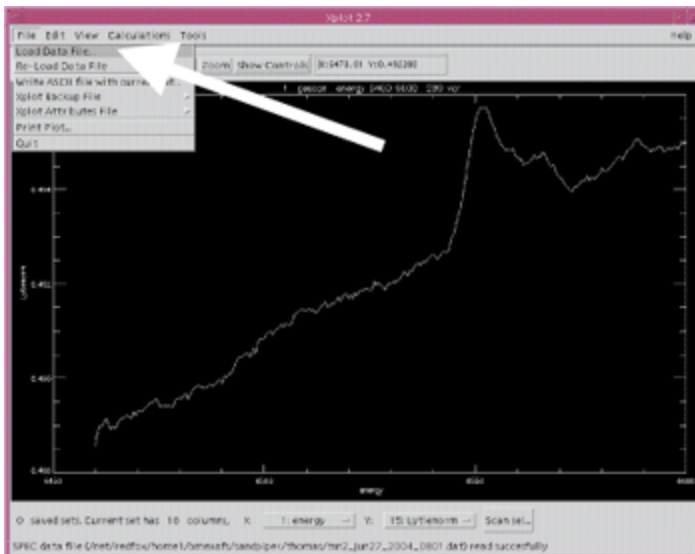
- Plotting in SPEC - SPEC will plot curves for different ion chambers as desired. To change the default displayed on screen: plotselect <ion chamber name>

Example:

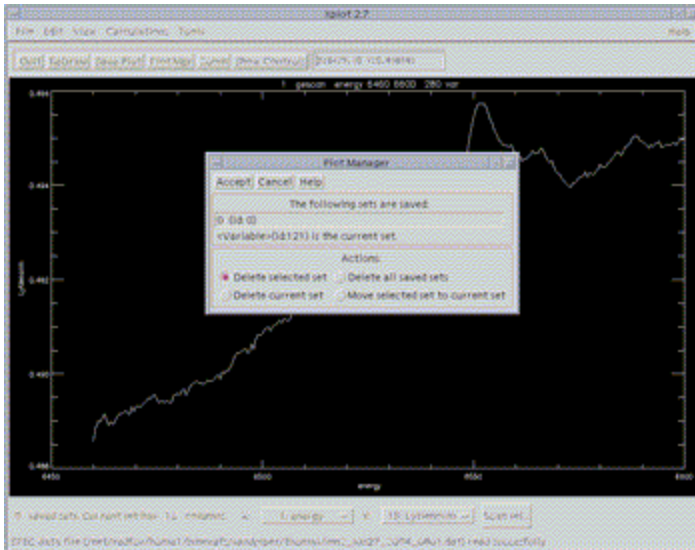
Plotselect i0

(Default I on Chamber

Plotted is i0)

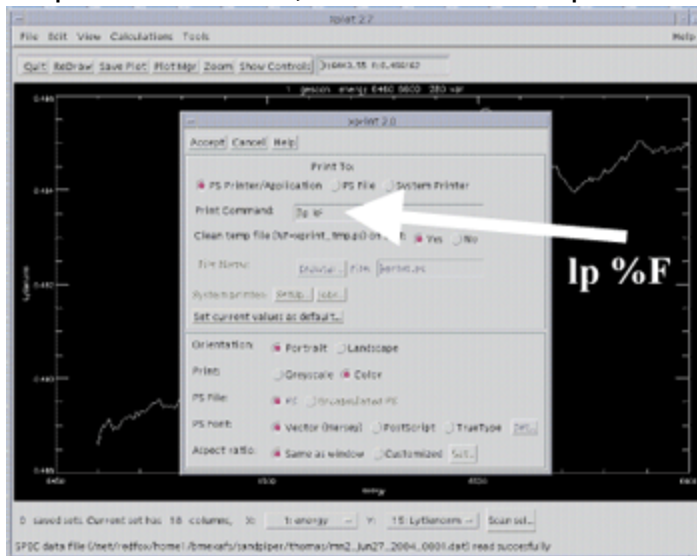


- **Plotting two or more sets of data simultaneously:** load a scan, hit “save plot” after each set is plotted. Keep track of the x- and y- scales when doing this; the scale is chosen automatically for the most recently-loaded set.
- **To clear the saved data sets:** Plotmgr→select set(s) to be cleared.



- **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".)



VIII. Secondary Computer Cheat Sheet:

- **Computer:** Hertz
- **User name:** CMCStaff
- **Password:** ask beamline staff
- **How to Transfer Data from Sandpiper to Hertz:**
 - Go to your directory on Hertz (on D: drive).
 - The files will be transferred to this directory.
 - Click on F-Secure SSH File Transfer icon
 - File menu-> connect
 - Connect to Sandpiper under bmexafs account
 - Go to the directory on Sandpiper that has the desired file(s)
 - Select the desired file(s)
 - Drag to your directory on Hertz

➤ **Data Analysis:**

Packages Available: WinXAS, Exafspak, Athena

IX. Why am I not Getting Beam?

Common Reasons:

1. Has the gas ran out (or is not on) in the sample chamber, I 2, or front part of the experimental setup in 9-BM B? For the front part of the setup, if the bubble bottle is not bubbling and the gas is not out or turned off at the tank, adjust the flow on the tank. For the sample chamber and I 2, check the flow meters inside 9-BM B.
2. Has the beam moved since the last beam dump? The most common fix for this is to translate btable by a few mm. Use EXAFS flag to visually evaluate where the beam is. Check the feedback system to make sure the beam is in range.
3. Is the shutter open? (Don't laugh.)
4. Is a flag blocking the beam? (Check Flag 6 especially.)