

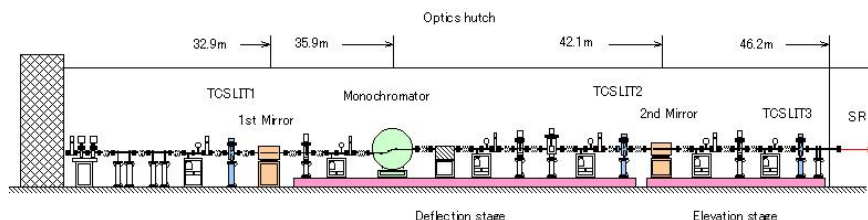
Contents

- 1 Outline
- 2 Alignment of x-ray optics
- Appendix

1 Outline

1-1 Arrangement of x-ray optics and measurement system

- in Optics hutch : 1st slit (TCSLIT1) → 1st collimating mirror → Double crystal monochromator → TCSLIT2 → 2nd vertical focussing mirror → TCSLIT3
- in Experimental hutch : → Slit (4DSLIT) → 1st ionization chamber (IO) → Sample → 2nd ionization chamber (I)
- TCSLIT : 4 blade slit in optics hutch
- 4DSLIT : 4 blade slit in experimental hutch





1-2 Outline of alignment

- The major operations carried out in the alignment of the x-ray optics are as follows:
 - Switching of the diffraction plane of the monochromator
 - Changing of the glancing angle of the mirror
- The above operation slightly changes the beam height downstream of the monochromator.
- Fine adjustment are done by measuring the x-ray intensity using the 1st ionization chamber in the experimental hutch.
- The height of experimental stage in the experimental hutch is adjusted to x-ray beam by scanning it in the vertical direction.
- A fixed beam condition is achieved by adjusting the rotation angle of the 1st crystal of the monochromator around the beam axis relative to the 2nd crystal.
- The control program for the operation of the x-ray optics gives rise to the following x-ray beam conditions.
 - Low higher harmonic contamination ($<10^{-5}$).
 - A fixed beam position during XAFS scan passing through the center of 4DSLIT in the experimental hutch.
 - A focused beam in vertical direction (0.1-0.2 mm).

1-3 Outline of operation

- First, the user must prepare the system for carrying out the alignment procedure.
- Next, the user aligns the x-ray optics using a program written in LabVIEW from the control PC (Gaia)

automatically.

- The user of the alignment software has only two types of interaction with the program:
 - Input parameters in setup window.
 - Click the OK button  or the Move button .

1-4 Rules for operation

- Each user group should have more than one BL01B1 expert during their beamtime.
 - The program operator needs prior approval (an operators license) to carry out alignment of the x-ray optics from the BL01B1 beamline staff.
 - The criteria for receiving a licence are as follows:
 - Knowledge of the arrangement and function of the x-ray optics of BL01B1.
 - An understanding what constitutes abnormal or dangerous situations during the alignment operation and how to stop the procedure if required.
 - Users must ask permission from the BL01B1 beamline staff to operate program from 17:30 to 9:30 on weekdays and for all times on weekends.
-

2 Alignment of the x-ray optics


2-1 Preparations before starting the alignment program

- Setup the system for x-ray measurement in the experimental hutch.
 - Select and flow adequate and appropriate gas to the ionization chamber.
 - An adequate absorption ratio is 10-30 % for the IO chamber and 80-90 % for the I chamber, respectively.
 - The absorption ratio can be calculated using the Excel file: IO_gas_absorption.xls in the Desktop folder of the PC (**Ganimede** or next to **Gaia**).
 - Connect the HV cables from the ion chamber to the 1040 V on the HV supply (battery).
 - Check that the cable lengths allow for sufficient play during the vertical movement of the experimental stage (on the order of 100 mm).
 - Properly close the experimental hutch.
 - Close the MBS (Main Beam Shutter).
 - Close the DSS (Downstream Shutter).
- Check that the power is on for the pulse motor controller **PM16C A** in the equipment rack near the PC.
- Check that the power is on for the stepper motor drivers: channels 0 to 5 (located under the PM16C A).
- Restart the PC **Gaia**.
 - Ask the BL01B1 beamline staff for the password.
- Check the monochromator Bragg angle displayed on the encoder readout located above the PC Gaia.
 - If Error 3 is displayed, push the CLR button to display the correct angle.


2-2 Precautions during program operation

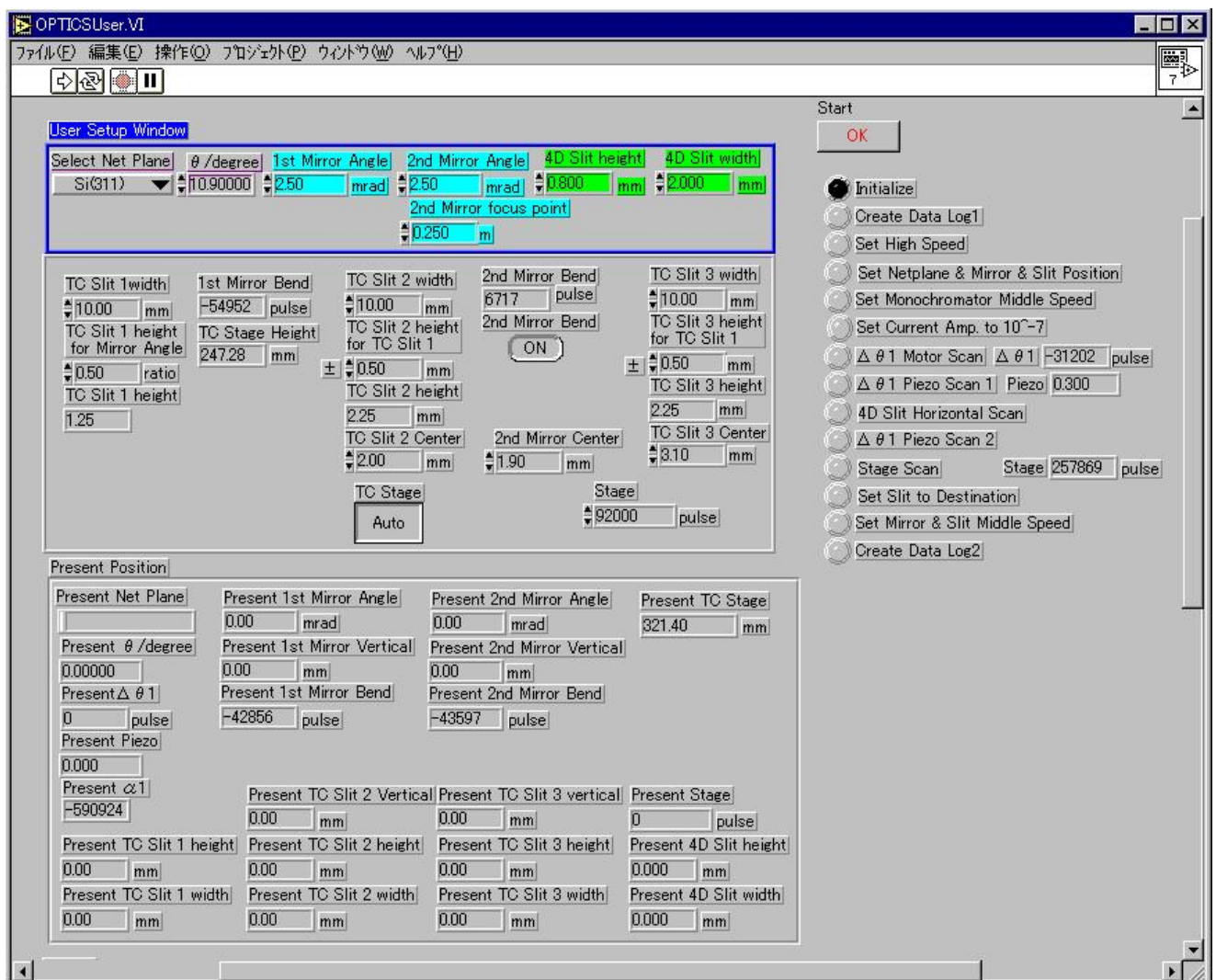
- Beginner operators must read appendix B before starting the program.



2-3 Starting the program operation

- Run the program Menu2.vi
- Select the sub-program Netplane & Mirror from the pop-up menu .



- Click Run button .
 - the Optics.vi will then open.



- Click the Run button .
 -  Initialize the red light will blink momentarily and then turn black.
 - The present status of the x-ray optics is displayed on the User Setup Window.



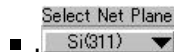
2-4 Input of parameters for the x-ray optics in the User Setup Window

- The user is allowed to set parameters in the User Setup Window. Don't change any parameters in the other

sub windows.

- Set the monochromator parameters.

- Select diffraction plane (net plane).



- Don't select Si(733) as this setting is still in development.

- Input a Bragg angle for the monochromator near the absorption edge of target element.



- Don't input a Bragg angle higher than 20 degrees in this program.

- This limit applies only to this program. XAFS measurement can be done at angles higher than 20 degrees.

- Setting parameters for the mirrors.

- Input the desired glancing angle of the 1st mirror (in mrad) .



- Adequate glancing angle of mirrors, θ (mrad), are calculated by follows

- $\theta = (60 / (E_{\text{max}} + 3)) - 0.15$ $E_{\text{max}} < 15 \text{ keV}$

- $\theta = (50 / E_{\text{max}}) - 0.15$ $E_{\text{max}} > 15 \text{ keV}$

- where E_{max} (keV) is maximum energy of XAFS scan.

- In the case where the mirrors are not used (e.g. are not in the x-ray path), input 0 (mrad).

- Input the same value for the glancing angle for the 2nd mirror as for the 1st mirror.



- Set the focus position relative to the 4DSLIT (meters). The error in this position is less than 0.4 m.

- Input 0.25 m when the sample is set just downstream from the IO chamber.

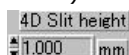


- Input 0.6 m when the sample is mounted on the 2-axis diffractometer.

- Input the desired slit widths for the 4 blade slit in the experimental hutch (4DSLIT)..

- Input the vertical width of the 4DSLIT (height).

- For a focused beam, the vertical beam size is 0.1-0.2 mm. In this case, input 0.8 mm (the default value).



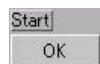
- Input a horizontal width for the 4DSLIT (width) appropriate for the sample being measured (min.=0.1 mm, max.=10 mm).

- Don't set the slit width lower than 0.1 mm due to limitations of the hardware.



- The 4DSLIT width can be changed by another program (4DSLIT move) after the completion of the optics program.

2-5 Start the program



- Click Start OK button

- This program automatically then goes through the steps listed on the right side of the window.

- A blinking red light indicates the active step.

- A black light indicates a completed step.



- The window then opens.

- Check the GUI on the x-terminal of the beamline workstation. If the GUI appears on the display,




Click the OK button.

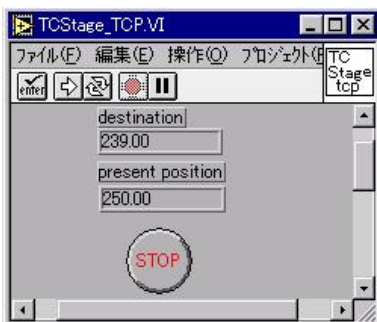


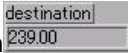


- The window then opens.
 - After checking the gas flow to the IO chamber, click the OK button.

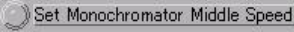



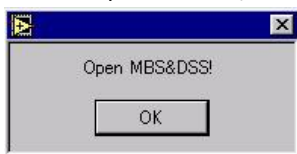
- The window then opens.
- After checking that the MBS and the DSS are closed, click the OK button.
- It is necessary to close the MBS and DSS during the initial part of the alignment procedure to ensure that stray radiation does not damage components of the mirror and monochromator.

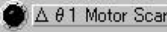
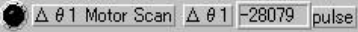
-  **Create Data Log1** Red light blinks for a moment, and turns to black soon.
 - The present position of x-ray optics is saved in log file.
 - A new file folder for the log file is created under %c¥user¥BL01B1_data¥Optics_log in User PC Gaia; the name of the folder is the present date.
-  **Set High Speed** the red light will blink momentarily and then turn black.
 - The movement speed of each axis is set to high speed.
-  **Set Netplane & Mirror Angle & Slit Position** The red light blinks.
 - Each x-ray optical component is sent to its target position at high speed.
 - All commands to move x-ray optics are sent in parallel.
 - Time to finish movement
 - Switching between Si(111) and Si(311) : 6 min
 - Switching between Si(311) and Si(511) : 2 min
 - Changing glancing angle of mirrors : 5 min
 - After movement of the x-ray optics is complete, the elevation stages on which the x-ray optics are mounted are moved.




- The window opens.
- The target position of the elevation stage is displayed in  .
- During movement, the present position of elevation stage is displayed in  in real time.
- The present position of elevation stage is also displayed on the TV monitor.
- The elevation stage move at high speed until 2 mm from the target position, and then change slow speed .
- In the case of an emergency,
 - First, click emergency stop button  .
 - Then call the BL01B1 beamline staff.
 - Example emergencies include:
 - The elevation stage moving in the direction opposite to the target position or going through the target position.
 - Noise from motor gear or similar problem.

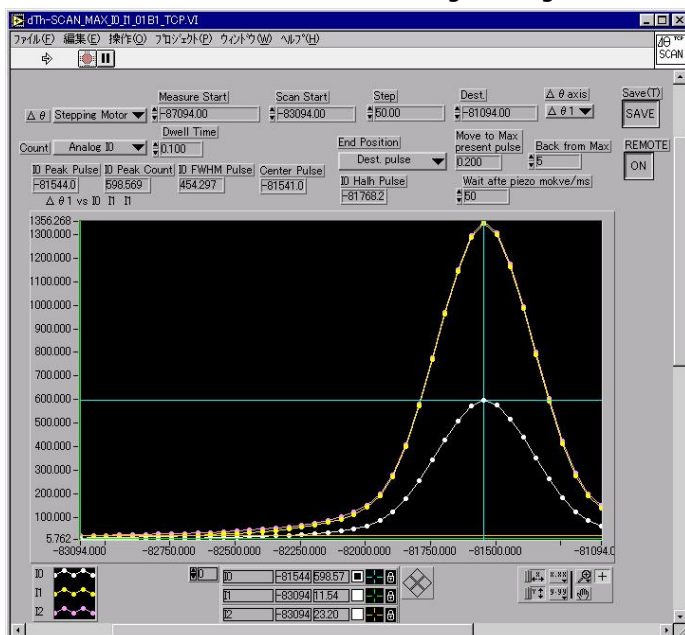
-  the red light will blink momentarily and then turn black.
 - The speed of the x-ray optics is changed to the intermediate speed setting automatically
-  Red light blinks for a moment, turns to black soon and have beep.
 - The range of current amplifier is set to 10^{-7} automatically.
 - The beep is normal, don't worry about it.




- The  window opens.
 - Open the MBS, and then the DSS.
 - Click the OK button.
 - Using the x-ray beam, the optics are precisely aligned by monitoring x-ray intensity using the IO chamber.
-  the red light will blink momentarily and then turn black.



- The  window opens.
- In this step, the monochromator is roughly adjusted to have the maximum diffracted x-ray intensity.
- Click the OK button.
- キャンセル means cancel.
- A rocking curve measurement using the stepping motor is now carried out.
 - It takes 20-30 sec before starting rocking curve scan starts.




-  window opens.
- Check the rocking curve profile.
 - In the case of both sides of the half maximum are in the scan range, the scan finished successfully. If so, click the Move button. It takes 20-30 sec before the monochromator moves to the center position of rocking curve.



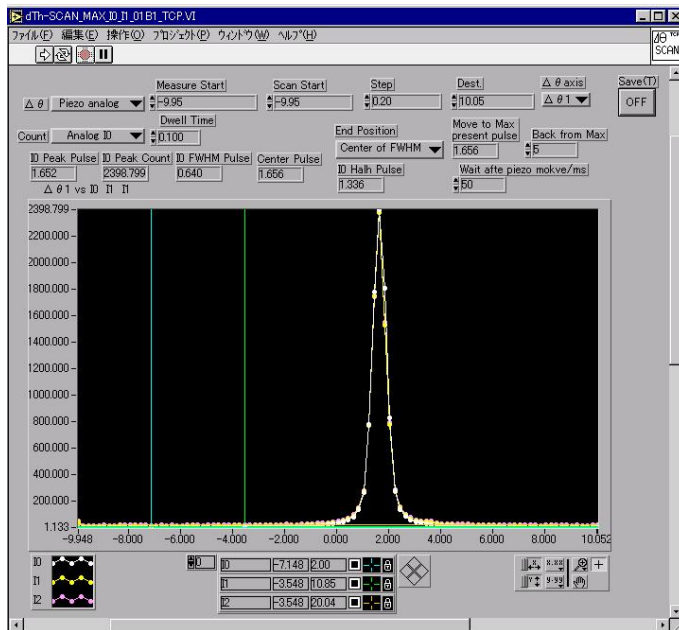
- If one or both sides of the peak are not in the scan range, rescan with the appropriate range. When ready click the Scan button.

- After this step, monochromator has been roughly adjusted to have a maximum in diffracted x-ray intensity, but the position is only approximate due to the backlash of the stepping motor.


-  $\Delta \theta$ 1 Piezo Scan 1 Piezo 0.335 the red light will blink momentarily and then turn black.

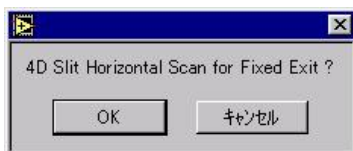


- The window then opens.
- In this step, the monochromator is precisely adjusted to have the maximum diffracted x-ray intensity.
- Click OK button.
- A rocking curve measurement using the piezo actuator is now carried out.

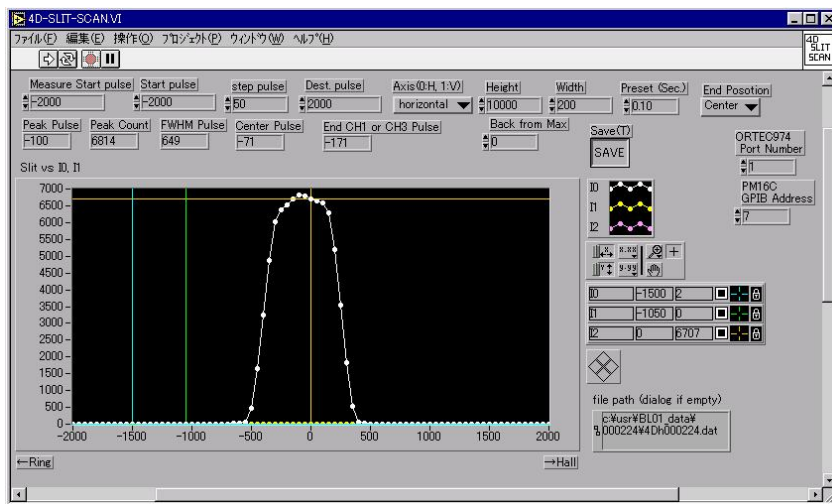


- After the rocking curve scan completes, the window opens.
- After checking if the scan finished successfully, click the Move button.

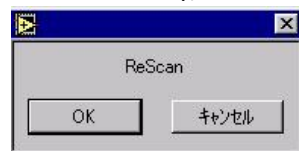
-  4D Slit Horizontal Scan 1 the red light will blink momentarily and then turn black.



- The window opens.
- In this step, the rotation angle of the 1st monochromator crystal around x-ray axis, $\Delta\alpha$, is adjusted to be parallel to the 2nd crystal.
- Click the OK button.
- The horizontal beam profile is measured by scanning the 4DSLIT in the experimental hutch.



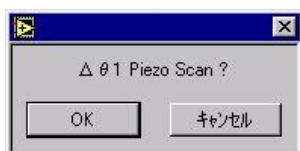
- After the scan, the Pos.Dialog.vi window opens.
- If the 1st crystal and 2nd crystal are perfectly parallel, the horizontal beam position is at the zero position.
- The misalignment in $\Delta\alpha$ is calculated from the observed horizontal center of the x-ray beam and shown in the above window.
- After checking scan finished successfully, click the OK button.



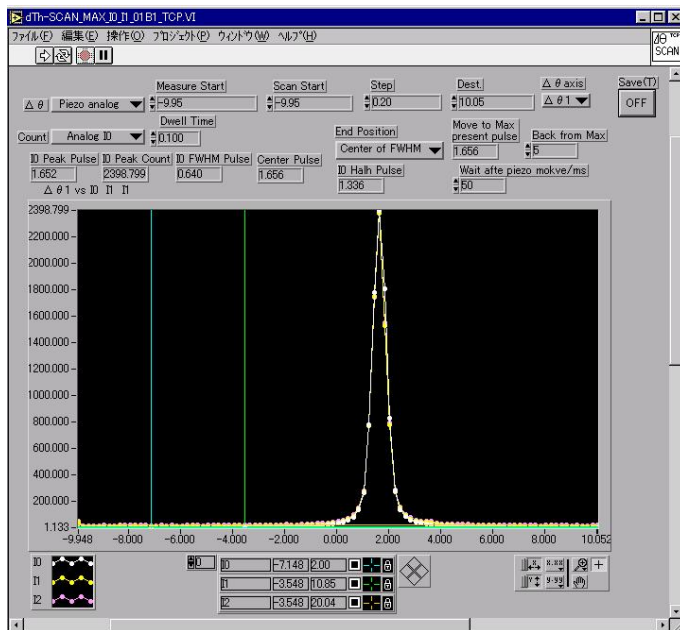
- After the $\Delta\alpha$ movement, the ReScan dialog box opens.
- If $\alpha < -10$ or $10 < \Delta\alpha$, a rescan of horizontal beam profile is needed. If so, click the OK button.
- If $-10 < \Delta\alpha < 10$, click cancel button, キャンセル (in Japanese).
- Repeat this step until $-10 < \Delta\alpha < 10$.
- After this step,
 - A fixed exit beam condition is achieved.
 - The X-ray beam position is at the center of the 4DSLIT in the experimental hutch.

-  $\Delta\theta 1$ Piezo Scan 2 the red light will blink momentarily and then turn black.

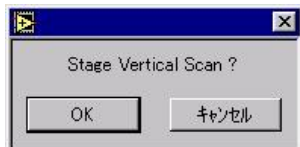
- In this step, the rocking curve is remeasured to adjust the 1st crystal position due to changes induced by the $\Delta\alpha$ movement.



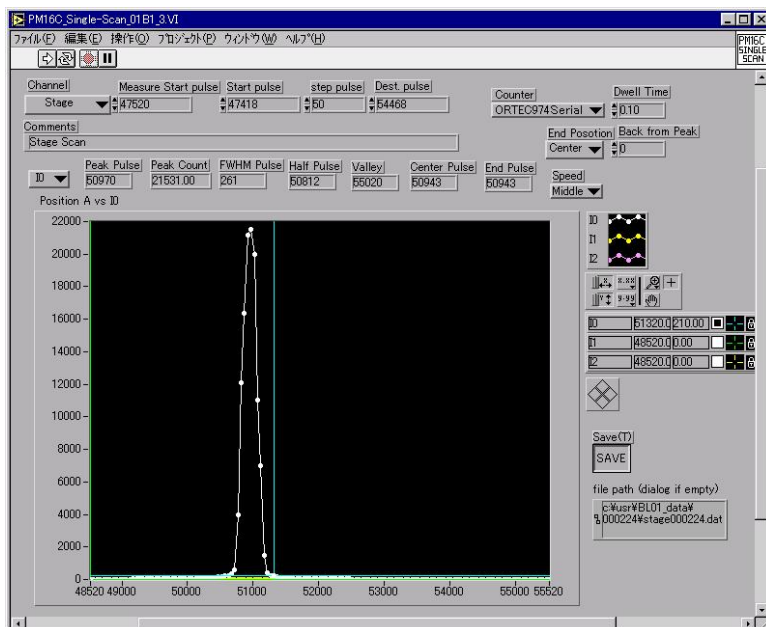
- The $\Delta\theta 1$ Piezo Scan ? window opens.
- Click OK button.
- A rocking curve measurement using the piezo actuator is performed.



- After the scan, the **Move_ReScan.vi** window opens.
- After checking that the scan finished successfully, click the Move button.
- **Stage Scan** the red light will blink momentarily and then turn black.



- The **Stage Vertical Scan ?** window opens.
- In this step, the stage for mounting the measurement system and sample in the experimental hutch is adjusted to match the height of the x-ray beam.
- Click the OK button.



- After the scan, the window opens.
- After checking that the scan finished successfully, click the Move button.
- After this step, the x-ray beam is at the center of 4DSLIT in the experimental hutch.
- Set Slit to Destination the red light will blink momentarily and then turn black.
 - In this step, the width of the slits in the optics and experimental hutches are set to the target value.
 - It takes 1-2 min to complete the movement.
- Set Mirror & Slit Middle Speed the red light will blink momentarily and then turn black.
 - The speed of mirrors and slits are set to the middle speed.
- Create Data Log2 the red light will blink momentarily and then turn black.
 - The last position of x-ray optics is added to the log file.
 - If there is any trouble with x-ray beam condition, beamline staff will check this log file.

2-7 Operations after completion of the program


- At the end of the program, Optics.vi shows following status.
 - Run button turns to .
 - The stop button turns to .
 - All the steps in the right side column are indicated in black .
- After checking the normal completion of the program, carry out the following operations.
 - Close all the windows opened during program by using the close button .

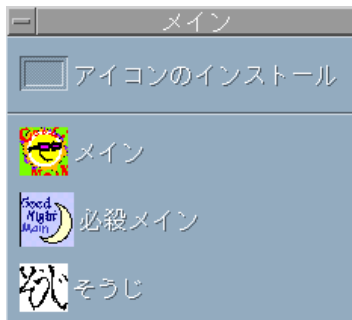
Appendix A

- **Restart operation of X-terminal of beamline work station**

- This description is based upon the "How to use beamline work station" manual http://okutsu.spring8.or.jp/blcntl/Man_GUI/cde/cde.html.

- These operations are done on the X-terminal of the beamline work station, not on the PC.
- Stop the GUI.

- Click the main button, メイン, above the  button on the front panel.



- The window opens.

- Click close GUI button, .


- Click clear buffer button .

- Restart the GUI by clicking main button .
 - It takes 10 s to finish the restarting of the GUI.

Appendix B

- **Basic operation for the program.**

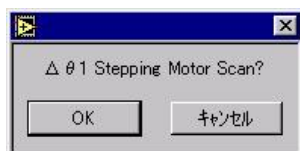
- Points

- The operator must check at each step in the program whether there are problems during operation.
- When something make a noise in the optics or experimental hutchs, stop the program by clicking on the stop button  as soon as possible, and call the BL01B1 beamline staff.
- When changing the parameters in setup window during the operation of program, click the stop button in the main window or click the cancel button in all the steps described below.

- Confirmation windows

- After checking points described below, click the OK button or the Move button.
- There are three checking window in this program.

- For a window asking whether or not to do the next scan, click the OK button.



- For a window asking for the status of instrument, click the OK button after checking the status of the



- For a window asking to move or scan instrument,
 - Check the measured curve profile.
 - When both sides of the half maximum are in the scan area, the scan finished successfully. Click the Move button.
 - If this is not the case, rescan after changing scanning range to the appropriate value. When done, click the Scan button .