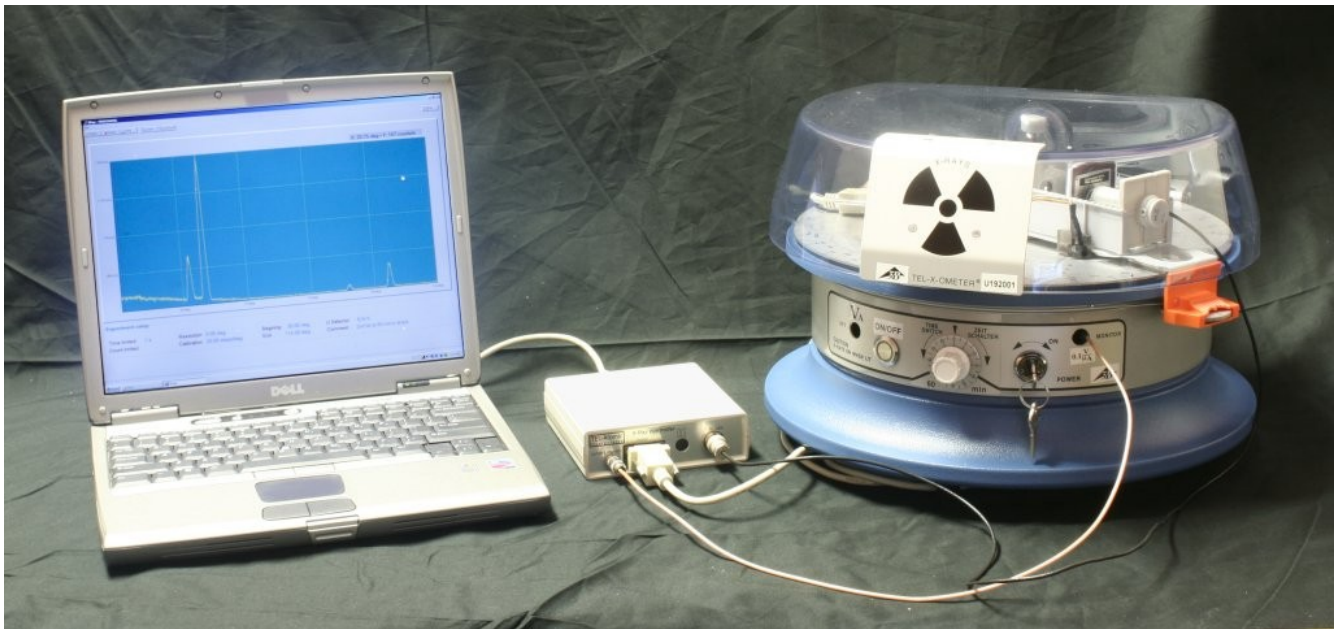# TEL-218DRV
TEL-X-Driver

TEL-Atomic, Incorporated
P.O. Box 924
Jackson, MI 49204
1-800-622-2866 – FAX 1-517-783-3213
email: telatomic@mindspring.com
website: www.telatomic.com

Features

- Angular Resolution: 0.05° - 1.00°

- Time per step: 0.1 - 20 seconds

- Approximate data range 12° - 115°

- Automatic scaling of Y axis

- X-ray tube current monitoring

- Automatic data backup

- Offset calculation based on LiF diffraction peak

- GM tube voltage selection

- Export data to spreadsheet for analysis

- RS 232 connection

Table of Contents

Introduction

System Overview:

The TEL-X-Driver is a combination of software and hardware designed to extend the capabilities of the TEL-X-Ometer x-ray machine. The TEL-X-Driver allows the user to collect x-ray diffraction data from a wide variety of crystals, powders, and metals. Included in the TEL-X-Driver is a stepper motor that interfaces directly with the TEL-X-Ometer, a control unit that drives the stepper motor and also runs a Geiger-Mueller tube, and the software program, x-ray.exe, that allows the user to control the TEL-X-Driver and collect data. The TEL-X-Driver software runs on any Microsoft Windows operating system, including Windows Vista.

Hardware List

The TEL-X-Driver package contains the following hardware:

- Control box
- Motor Assembly (Stepper motor with attached photo sensor)
- Drive gear
- Carriage arm retaining washer
- Thumbscrew for crystal clamp
- Power supply
- Serial Cables (2)
- Powder Compressor

Setup:

Overview

Setup of the TEL-X-Driver hardware is quite simple. The drive gear is installed on the central drive shaft, which allows the stepper motor to rotate the carriage arm and crystal post. The carriage arm moves .05° for every step of the motor. The photo sensor attaches to the carriage arm and detects the Home Position Markers. When the Home Position Markers are detected, the control box prevents the carriage arm from contacting the x-ray tube or the radiation shield. Serial cables connect the Motor Assembly to the control box, and the control box to the computer.

Step by Step Instructions

Installing the drive gear assembly:

1. Remove the crystal post and jaw assembly.
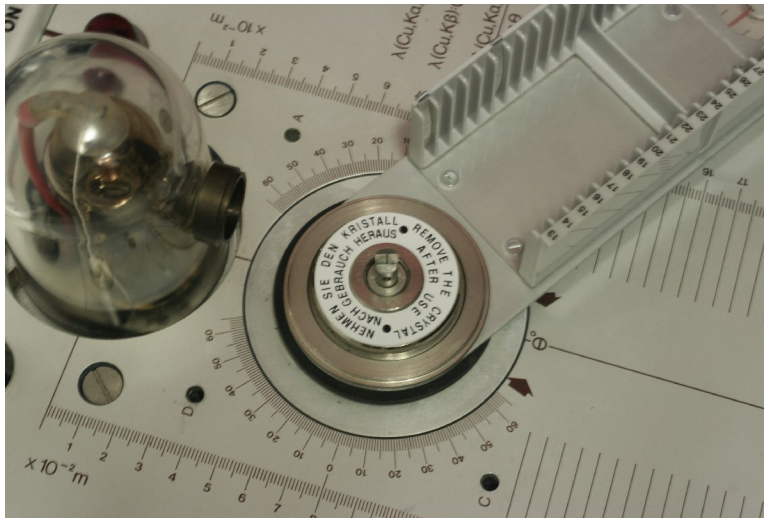
2. Remove the knurled clutch plate and four-lobed washer.
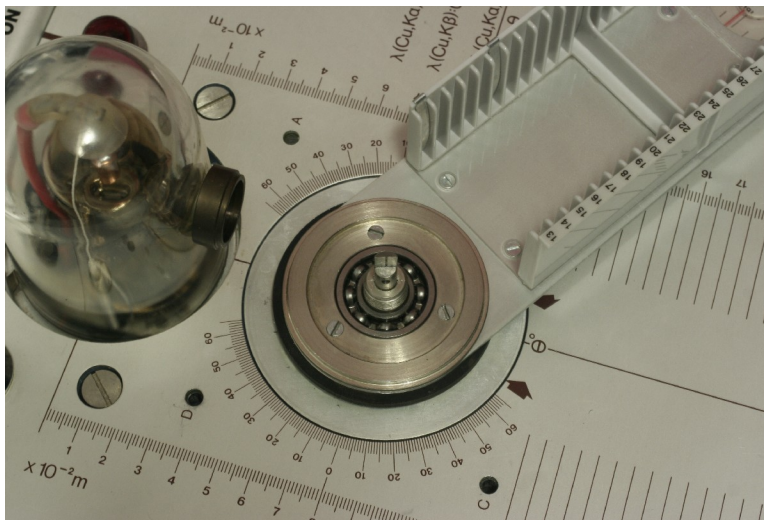
3. Remove the three screws securing the round metal plate on top of the detector arm. Remove the metal plate.
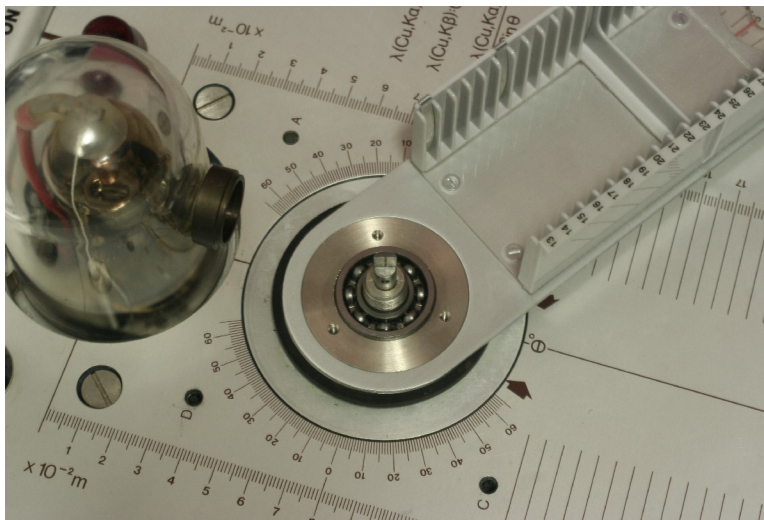
4. Install the provided washer on top of the carriage arm, and install the plastic gear over the washer. Save the metal plate from step 3 in a safe place. Then, replace the three screws removed in step 3.
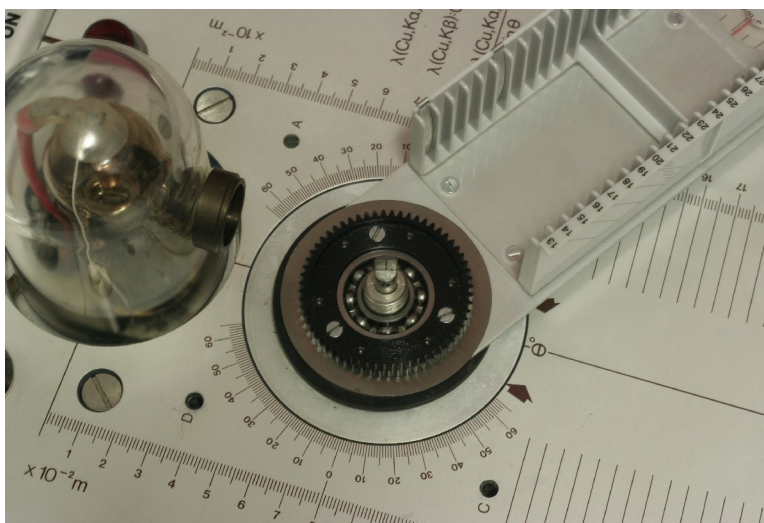
5. Replace the four-lobed washer. The sharp edge at the center of the washer must point down.
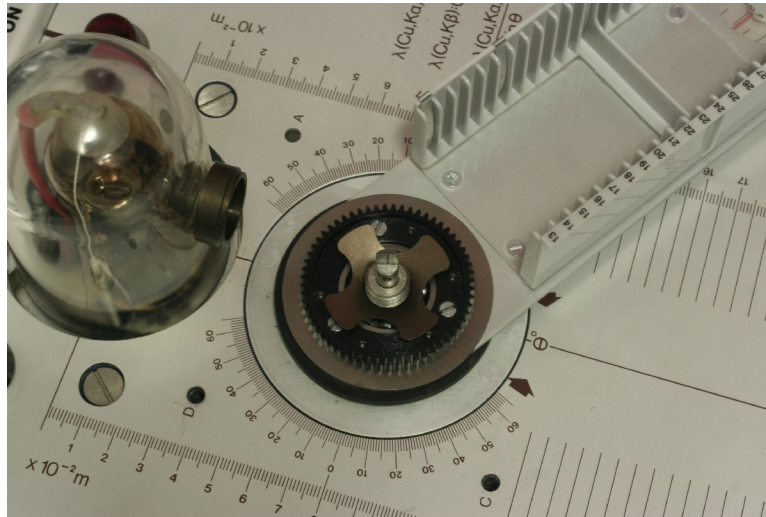
6. Replace the knurled clutch plate.
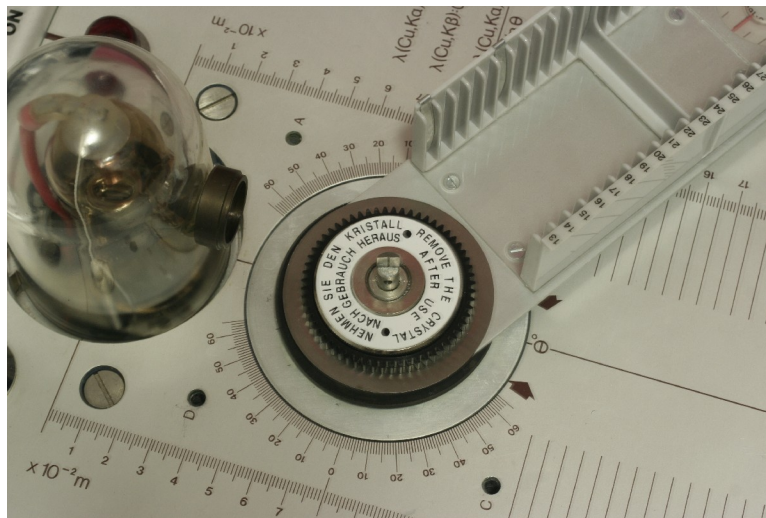
7. Replace the crystal post and jaw assembly. Use the provided thumbscrew instead of the thumbscrew provided with the TEL-X-Ometer.

Installing the Stepper Motor Assembly:

1. Place the Stepper Motor Assembly on the left side of the mounting post. The banana plugs fit into the holes on the TEL-X-Ometer.
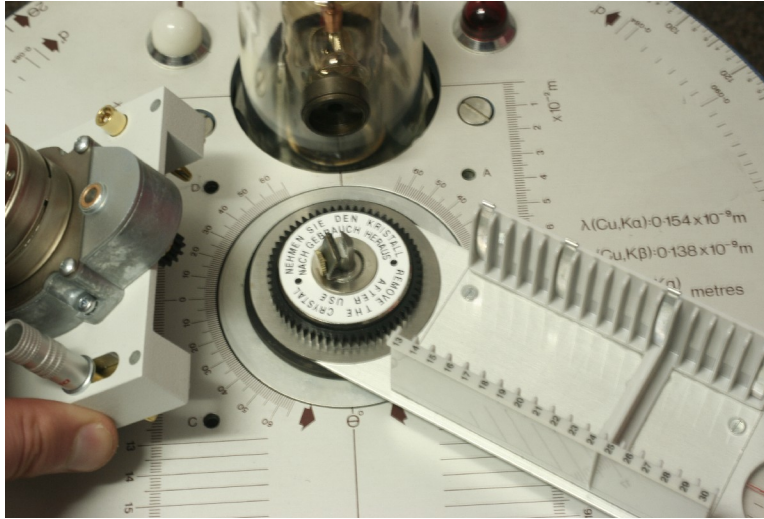
2. If necessary, rotate the sample arm so that the gears mesh.
3. Tighten the thumbscrew to secure the Stepper Motor Assembly in place.
4. Using the provided double stick tape, attach the photo sensor to the left side of the carriage arm as shown.
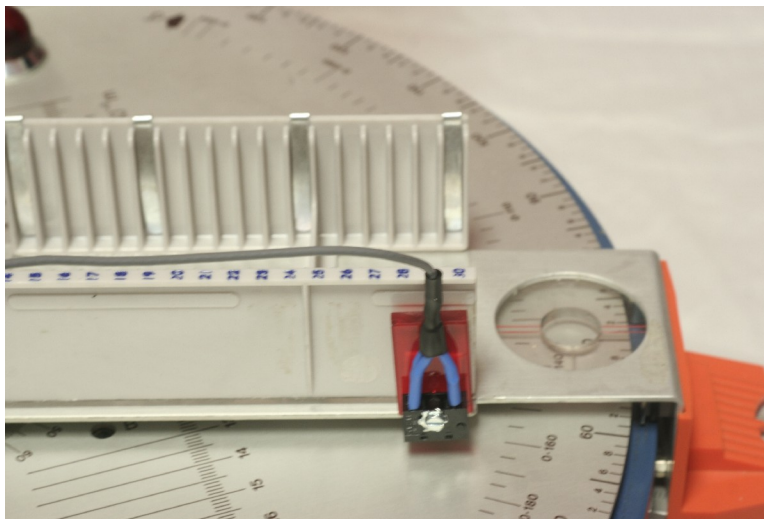
5. Affix the *Home Position Markers* so that the photo sensor will pass over them at the carriage arm rotates. They must prevent the carriage arm from contacting the radiation shield or the x-ray tube. For this, they must be placed at approximately 5° and 100°.
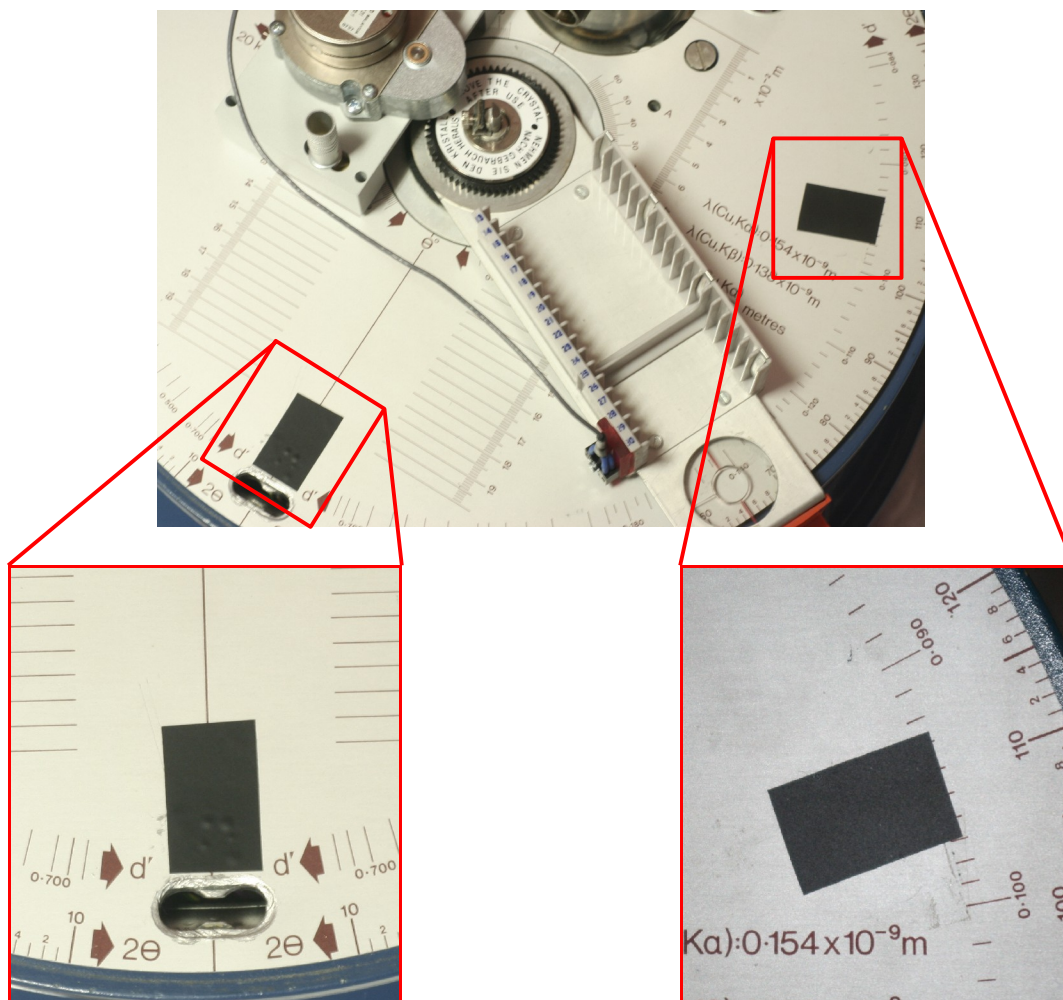
Installing the Stepper Motor Controller:

1. Attach a serial cable from the "motor" output on the TEL-X-Driver to the port on the Stepper Motor Assembly.
2. Attach the remaining serial cable to your computer's serial port (or to a USB to serial converter, and then to your computer). Attach the other end to the "PC" output on the TEL-X-Driver.
3. Plug in the 12VAC transformer to a 120V outlet, and plug the other end into the "power supply AC 12V/2A" jack on the TEL-X-Driver.
4. Insert the tube current monitoring cable into the jacks on both the stepper motor controller and the TEL-X-Ometer.

Software Installation

1. Insert the TEL-X-Driver Software CD into your computer's CD-ROM drive.
2. Open windows explorer and navigate to your CD drive. Double click on "setup.exe" to start the install program. Follow the prompts until all software has been completely installed.

Software Documentation

Overview

The TEL-X-Driver control program allows the user to input a range of angles, a resolution, and a time per step. Once the "Start" button is pressed, the TEL-X-Driver moves the carriage arm to the lower end of the angle range and begins counting. Once the selected time per step has been reached, the TEL-X-Driver software plots the number of counts for that angle on the graph window. The TEL-X-Driver then advances the carriage arm to the next angle, counts and plots again. This continues until the carriage arm reaches the upper end of the angle range. The TEL-X-Driver control program has many features, including support for multiple angle ranges in a single run, the ability to introduce an angular offset based on the x-ray diffraction data of LiF, and current monitoring.

Setup Instructions

Connection and Basic Setup

1. Start the TEL-X-Driver control software.

2. From the *Device>>Communication Port* menu, select the address of the serial port to which the TEL-X-Driver is connected.

3. From the *Device* menu, select *Connect*

4. A dialog box should come up once the unit is connected. If the settings are correct, click *yes*. If they are not correct, or this is your first time using the instrument, click *no*.

5. If you selected *yes*, you should proceed to the next section, *Testing the Configuration*.

6. Select an arm position. If you have mounted the TEL-X-Driver Motor Assembly on the left, you will select *right*, and vice versa. The diagram to the right changes to reflect your selection.
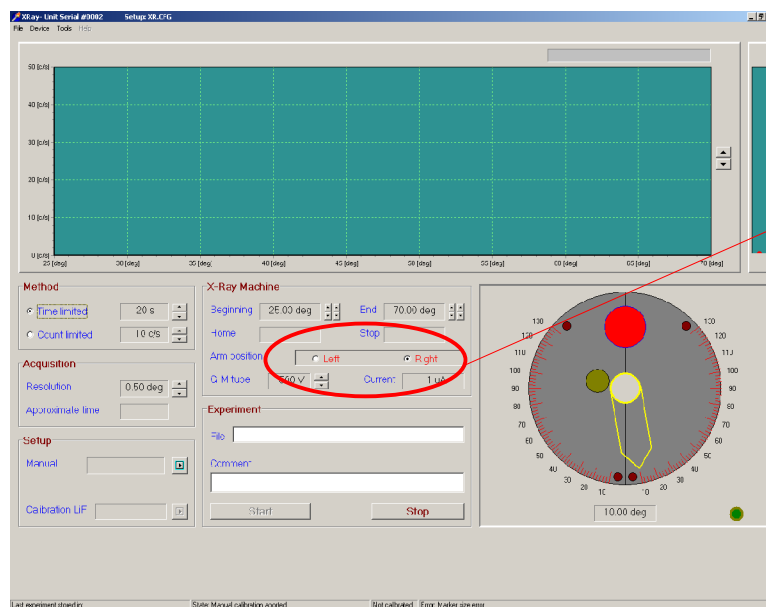
Arm Position Selection

7. Click the *Manual Setup* button. If you have applied the *Home Position Markers*, then you can select *yes* at the dialog asking "Home markers on place"
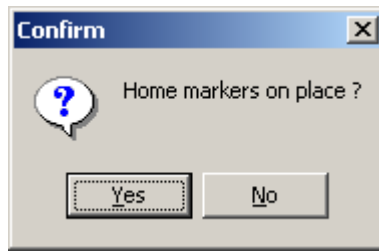
8. The carriage arm will rotate toward lower angles until it reaches a *Home Position Marker*. Once the carriage arm has stopped, read its current angle off the TEL-X-Ometer and input that angle into the dialog box.
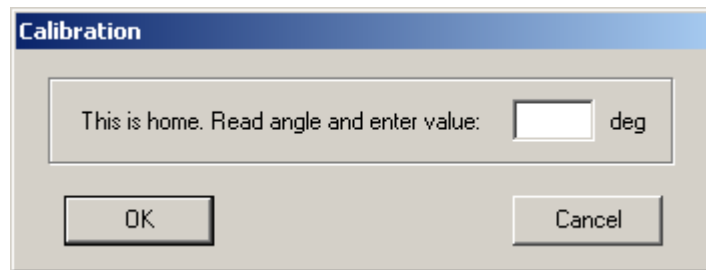
9. The carriage arm will now rotate in the opposite direction until it reaches another *Home Position Marker*. Again, read the angle and input it into the dialog box.
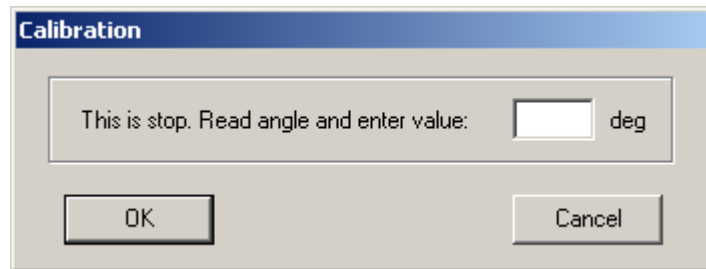
10. Wait for the arm to stop motion. The TEL-X-Driver is now ready to use.

Testing the Configuration

1. Insert a LiF crystal into the crystal clamp and tighten the thumbscrew. Put the 1mm slot primary beam collimator on the leaded glass dome in the vertical position, the 3mm slide collimator at E.S. 13, the 1 mm slot collimator at E.S. 22, and the GM tube at E.S. 30.
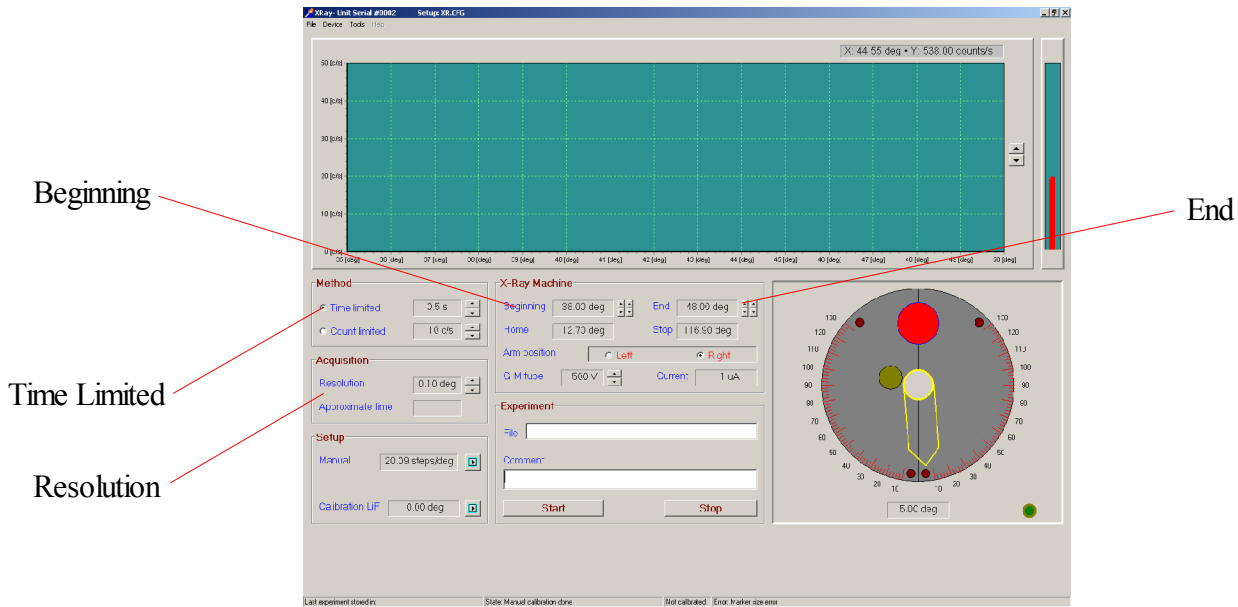
2. Adjust *Beginning* to 38° and *End* to 48°. Adjust the *Time limited* setting to .5 seconds and *Resolution* to .10°. Turn the x-rays on, then click start.

3. The TEL-X-Driver will move the carriage arm to the *Home Position Marker*, and will then rotate the carriage arm to 38° and begin taking data. Once the TEL-X-Driver has completed taking data, the *Data Collection w*indow should look like figure below.
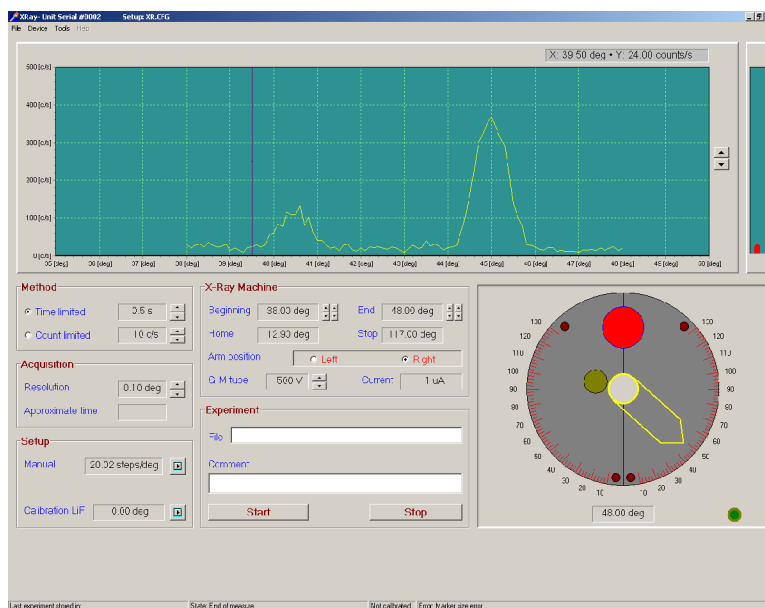
4. The TEL-X-Driver control program will automatically divide the number of steps the motor traveled by the angle through which the carriage arm traveled to calculate a number of steps per degree.   This number should be, based on the gear ratios involved, 20 steps /degree. Small deviations from this are caused by errors in reading the angles off of the TEL-X-Ometer.

You may now begin performing experiments, or you may proceed to *Offset Calibration* to improve the accuracy of angular measurements.

Offset Calibration

For improved accuracy, the x-ray diffraction pattern from a LiF crystal can be used to calculate an angular offset for the TEL-X-Driver.

1. Insert a LiF crystal into the cryatal post and jaw assembly and tighten the thumbscrew. Put the 1mm slot primary beam collimator in the vertical position, the 3mm slide collimator at E.S. 13, the 1 mm slot collimator at E.S. 22, and the GM tube at E.S. 30.

2. Turn on the x-rays and click on the "Calibration LiF" button. The TEL-X-Driver will automatically take data from 39° - 49°.

Calibration LiF
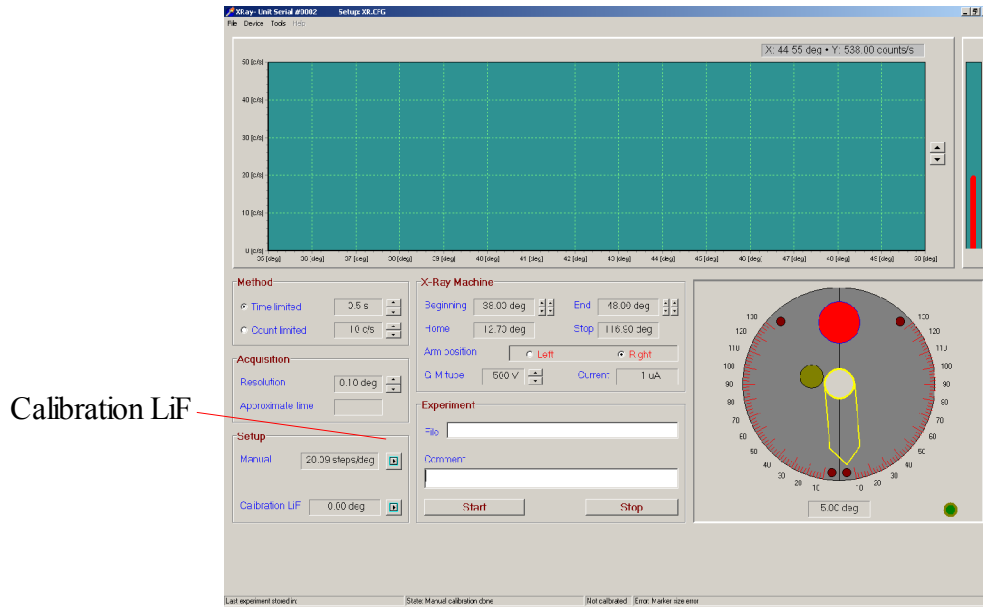
3. Once the scan is complete, drag the *Angle Indicator* from the left side of the *Data Window* to the angle with the highest number of counts. The angle and count rate are displayed in the upper right corner of the *Data Window*. Input this angle into the dialog box.

Angle Indicator
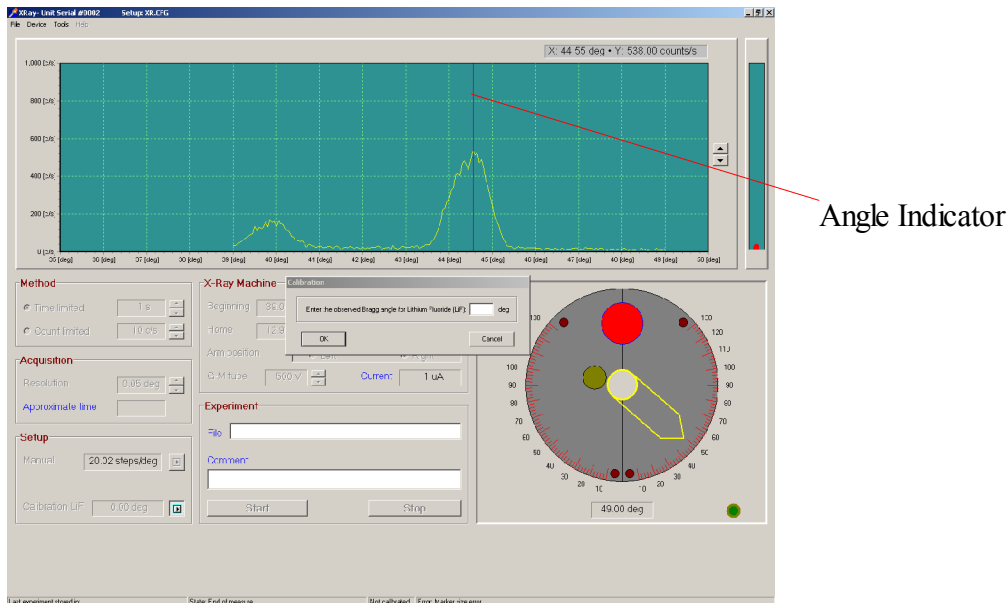
The diffraction peak of LiF and Cu Kα radiation is known to occur at 45.02°. The TEL-X-Driver uses the angle input by the user and the known angle to calculate an offset. This offset is then applied to all future measurements, ensuring that the diffraction peaks are measured at the correct angles. Due to resolution limits of the TEL-X-Driver, 45.00° is used by the TEL-X-Driver software instead of 45.02°. This offset is displayed next to the "Calibration LiF" button. In addition, beginning, end, home and stop are displayed in red to remind you that the offset is in effect.

Using the TEL-X-Driver

Basic Use

1. Start the TEL-X-Driver control software.

2. From the *Device>>Communication Port* menu, select the address of the serial port that the TEL-X-Driver is connected to.

3. From the *Device* menu, select *Connect*

4. A dialog box should come up once the unit is connected. If the settings are correct, click *yes*. If they are not correct, or this is your first time using the instrument, click *no*.

5. If you selected *yes*, you should proceed to the step 10.

6. Select an arm position. If you have mounted the TEL-X-Driver Motor Assembly on the left, you will select *right*, and vice versa. The diagram to the right changes to reflect your selection.

7. Click the *Manual Setup* button. If you have applied the *Home Position Markers*, then you can select *yes* at the dialog asking "Home markers on place"

8. The carriage arm will rotate toward lower angles until it reaches a *Home Position Marker*. Once the carriage arm has stopped, read its current angle off the TEL-X-Ometer and input that angle into the dialog box.

9. The carriage arm will now rotate in the opposite direction until it reaches another *Home Position Marker*. Again, read the angle and input it into the dialog box.

10. Insert a crystal into the sample clamp of the TEL-X-Ometer.

11. Assuming you do not know at what angle to expect diffraction peaks, select a wide range of angles over which to scan, 20° - 60°, for instance. If you do know the angle at which to expect diffraction peaks, you may adjust the range to bracket those angles.

12. Select a *Time Limited* value. 0.1 seconds is sufficient for locating peaks, but a longer time, such as 1 second, will yield higher quality data.

13. Select a resolution. If you are simply trying to find the peaks, a low resolution such as .2° will be sufficient. If you want high quality data, select .05°.

14. Turn the x-rays on and click *Start*. The projected time to complete your measurement will be displayed next to the *Approximate time* heading. Data will be saved automatically in the file XR.tmp every 30 seconds. This insures that data will not be lost in case of computer trouble or power outage.

Taking Data Across Multiple Angle Ranges (using Region of Interest)

In order to speed the process of taking data, the TEL-X-Driver control software has the ability to scan multiple angular ranges in a single range. If you wanted to capture data for a NaCl crystal, for instance, you could scan from 25° to 115°, a lengthy process. It is much quicker, instead, to scan from 25° to 35° (n=1 diffraction peaks), from 55° to 70° (n=2 diffraction peaks), from 93° to 112° (n=3 diffraction peaks).

1. To enable Regions of Interest, select *Regions of Interest* from the *Device* menu.

2. Select *multiple* at the top of the Regions of Interest dialog box.

3. Check the box next to each region of interest you want to use. Type in the beginning and end angles for each region as well. Each region of interest must begin at a larger angle than the end of the previous region of interest.
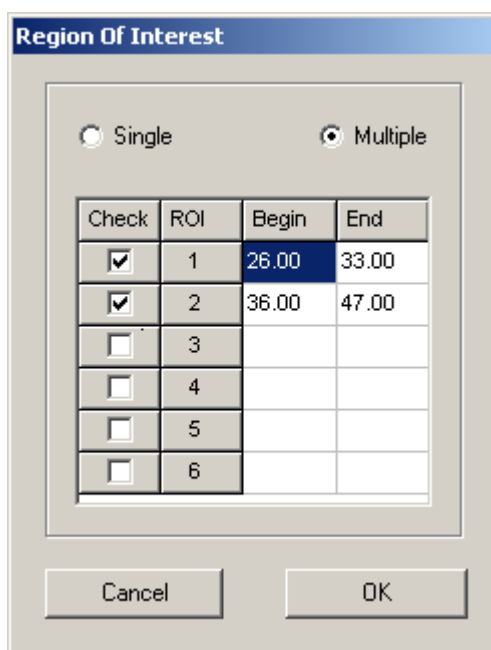
4. When you are satisfied with your Regions of Interest, click *OK*. You may now select resolution and time limited settings on the main screen. Click start to have the TEL-X-Driver begin on the first Region of Interest. The TEL-X-Driver will automatically scan through all Regions of Interest and display the results on screen.

Saving Data

1. Once a scan has completed, you may wish to enter info in the *Comment* section.

2. Select *File>>Save data as*.

3. Navigate to the folder in which you want to save data.

4. Input a file name that describes your measurement, and click *Save*.

   Data is also saved automatically in the file XR.tmp every 30 seconds. This insures that data will not be lost in case of computer trouble or power outage.

Loading Data

1. Select *File>>Data processing*

2. Click on *Open*.

3. Navigate to the folder containing your saved data. Select the data file you want to open and click *Open*.

   To load data that was saved automatically, rename the file XR.tmp to XR.dxr and then open it

using the above procedure.

Exporting Data

1. Open your data file as described above in *Loading Data*.

2. Click *Export.*

3. A text file will be created with the same name as your data file, but with the extension .txt. For instance, if your data file is called *NaCl.dxr*, the text file will be named *NaCl.txt*. The text file is created in the same directory as the TEL-X-Driver Control Program.

Taking Data Using Powders

Taking quality data from powders requires up to 6 hours. Powders are put in to the *powder compressor* and then into the TEL-X-Ometer. The signal from powders is much weaker than that for single crystals, so the TEL-X-Driver must count for a long time at each angle to minimize the effects of noise.

1. Place a *powder holder* on a hard, flat, clean surface (a table should be fine). Pour enough of your desired powder into the *powder holder* to fill the hole in the middle to the top.

2. Place the *powder compressor rod* into the hole of the *powder holder*. Tap the p*owder compressor rod* several times with a hammer.

3. Hold down the *powder holder* and carefully remove the *powder compressor rod.*

4. Place the *powder holder* in the *sample holder* of the TEL-X-Ometer. You may want to place a piece of clean scotch tape over the powder to ensure that the powder does not fall into the drive mechanism. The presence of the tape will not significantly effect the results of the experiment.

5. Select desired options for collecting data. A time limited experiment is recommended, using a 10 or 20 second count time.

6. Be sure not to let the timer on the TEL-X-Ometer run out. For very long experiments, it is possible to remove the timer knob and attach vice grips to the post in such a way that the TEL-X-Ometer will not shut off.

Using the TEL-X-Driver as a Scaler

The TEL-X-Driver has the ability to function as a scaler, counting with the Geiger-Mueller tube, but not using the stepper motor. This function is still under development, and should be completed by 2/15/18.

Appendix A: Description of Program Functions

Data Collection Window

Method box

Time Limited

Selecting this radio button puts the TEL-X-Driver in *Time Limited* mode. The TEL-X-Driver will count for the selected amount of time at each angle. This is the preferred mode of operation.

Count Limited

Selecting this radio button puts the TEL-X-Driver in *Count Limited* mode. The TEL-X-Driver will count until the selected number of counts are reached at each angle. If the selected number of counts are not reached before the "Time Limited" selection, then the TEL-X-Driver will advance the carriage arm.

Acquisition box

Resolution

Here the user can select a resolution from .05° to .5° to use for measurements.

Approximate time

Once an experiment is started, the projected time to complete the experiment is shown here.

Setup

Manual

Clicking on the button next to "Manual" will begin the setup process. During this process, the user inputs the "Home" and "Stop" angles. The TEL-X-Driver uses these angles to determine at what angle the carriage arm is located. Once the setup process if finished, the box next to manual will display the total number of steps the stepper motor took to get from "Home" to "Stop,"divided by the number of degrees separating "Home" and "Stop." This should come out quite close to 20 steps/degree. Small differences generally indicate that there were errors in the input angles.

Calibration LiF

Clicking on the button next to "Calibration LiF" will begin the calibration process. The unit will automatically scan from 39° to 49°. The user must then input the angle at which the LiF diffraction peak is observed. This peak is known to occur at 45.02°, so the TEL-X-Driver uses the angle input by the user and the known angle to calculate an offset. This offset is then applied to all future measurements, ensuring that the diffraction peaks are measured at the correct angles. Due to resolution limits of the TEL-X-Driver, 45.00° is used by the TEL-X-Driver software instead of

45.02°.

X-Ray Machine

Beginning

This box displays the lower angle at which the TEL-X-Driver will begin taking data if *Regions of Interest* are not being used. If *Regions of Interest* are being used, then the number here is irrelevant.

End

This box displays the angle at which the TEL-X-Driver will stop taking data if *Regions of Interest* are not being used. If *Regions of Interest* are being used, then the number here is irrelevant.

Home

The angle of the first *Home Position Marker*. This is the lowest angle at which data can be taken.

Stop

The angle of the second *Home Position Marker*. This is the highest angle at which data can be taken.

Arm Position

Radio buttons to select *Left* or *Right*. The TEL-X-Driver may be installed on either side of the central drive.

GM Tube

Displays the GM tube voltage. You may adjust this voltage from 452V to 520V in increments of 4V.

Current

Displays the x-ray tube current. This is intended for adjusting tube current only. The tube current data is not saved along with the counts and angle data.

Experiment

File

The file name you would like to use to save the current data.

Comment

A short comment that will be attached to the current data file when saved.

Display

Data Window

This window displays the angle and count rate data as measurements are taken. The *Angle Indicator* is by default located at the left side of the *Data Window*. The user may drag the *Angle Indicator* to any location on the *Display Window* and the count rate and angle will be displayed in the upper right corner of the *Data Window.*

Rate Bar

Located at the far right of the screen, this bar displays the current count rate.

Status Window

This window, located at the lower right of the screen, displays the current state of the TEL-X-Driver, including a graphical representation of the carriage arm position.

File menu

Save data as

Save the most recent data recorded. This option is unavailable if the most recent run was not allowed to complete, or if no data has yet been recorded.

Data Processing

Opens the *Data Processing* page.

Exit

Exits the TEL-X-Driver control program. Any unsaved data will be lost.

Device menu

Communication Port

Use this to select the address that corresponds with the serial port to which the TEL-X-Driver is connected.

Connect

Once the TEL-X-Driver is connected, selecting "Connect" will initiate communications between the TEL-X-Driver control software and the TEL-X-Driver control unit.

Manual Control

Opens a window that allows the user to move the carriage arm manually. Buttons are described below

Ignore markers

Allows the carriage arm to travel over the *Home Position Markers*.

Slow

Moves the carriage arm at a reduced speed.

Steps mode

Select a number of steps, and then click on the right and left arrows to move the carriage arm either clockwise or counterclockwise by the selected number of steps.

Continuous mode

Move the carriage arm clockwise or counterclockwise. The button in the middle stops the motion of the carriage arm.

Audio

Enables or disables the GM tube speaker on the TEL-X-Driver control box.

Region of Interest (ROI)

Opens the *Region of Interest* window.

Single/Multiple

If S*ingle* is selected, the angle over which the TEL-X-Driver scans will be controlled by the *Beginning* and *End* selections on the main screen. If *Multiple* is selected, angles will be controlled via the *Region of Interest*.

Check, ROI, Begin, End

In this section, check the box next to every ROI that is to be used. Input B*egin* and *End* angles for each region that is checked. Each *Begin* angle must be larger than the *End* angle of the previous ROI.

Tools menu

Display menu

Line

Toggles a line connecting each data point recorded.

Discrete

Toggles a marker at each data point.

Style

Allows the data points displayed by the *Discrete* option to be configured.

Restore

Returns the display to the default settings.

Calibration LiF

This will begin the calibration process, and provides the same functionality as the button on the main window. The unit will automatically scan from 39° to 49°. The user must then input the angle at which the LiF diffraction peak is observed. This peak is known to occur at 45.02°, so the TEL-X-Driver uses the angle input by the user and the known angle to calculate an offset. This offset is then applied to all future measurements, ensuring that the diffraction peaks are measured at the correct angles. Due to resolution limits of the TEL-X-Driver, 45.00° is used by the TEL-X-Driver software instead of 45.02°.

Service

This provides the ability to change the calibration coefficient of the *Tube Current* measurement. This may be necessary due to changes that were made to the TEL-X-Ometer in 2006. If you have a pre-2006 model of the TEL-X-Ometer, this option will not be necessary. For owners of post 2006 models, a supplement will be included explaining the use of this option.

Data Processing page

Toolbar

Open

Open a data file for viewing.

Export

Export the current data file to a .txt file with the same name. "LiF.dxr" would output as "LiF.txt". The .txt file will be located in the same folder as the TEL-X-Driver control program.

Print

Print the current graph on the default printer.

Zoom

This allows the user to zoom in on a particular section of data. To use, click on the *Zoom* button, then click on the left edge of the region on which you want to zoom. Click once more on the right edge of the region on which you wish to zoom.

UnZoom

Returns the display to its default setting.

ROI

By selecting a ROI here, the user can automatically zoom in on that ROI.

Exit

Return to the D*ata Collection* screen.

File menu

The *File* menu options of *Open*, *Export ASCII,*and *Print* perform the same functions as their counterparts in the toolbar.

Tools menu

Line

Toggles a line connecting each data point recorded.

Discrete

Toggles a marker at each data point.

Style

Allows the data points displayed by the *Discrete* option to be configured.

Restore

Returns the display to the default settings.

Experiment Setup

This section displays the TEL-X-Driver control program settings that were used to acquire the current data file.