

# **TEL-2590U**

# **TEL-X-Driver**

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# Features

- Angular Resolution:  $0.05^\circ$  -  $.50^\circ$
- Time per step:  $\geq 0.1$  seconds
- Approximate data range:  $12^\circ$  -  $115^\circ$
- 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
- USB connection

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# 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. The TEL-X-Driver interfaces directly with the TEL-X-Ometer, provides the high voltage and counting circuitry for a Geiger-Mueller tube or a Scintillator with photomultiplier tube, and includes a software program, 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:

- TEL-X-Driver
- Drive gear
- USB Cable
- Powder Compressor

## Setup:

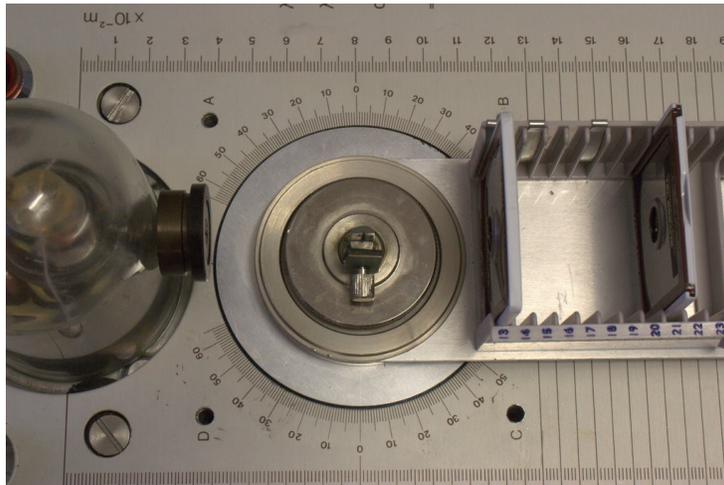
### Overview

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  $.05^\circ$  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.

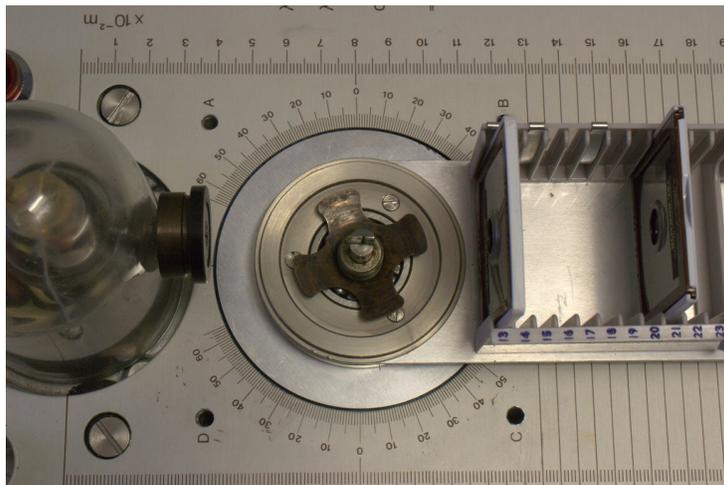
### Step by Step Instructions

#### Installing the drive gear assembly:

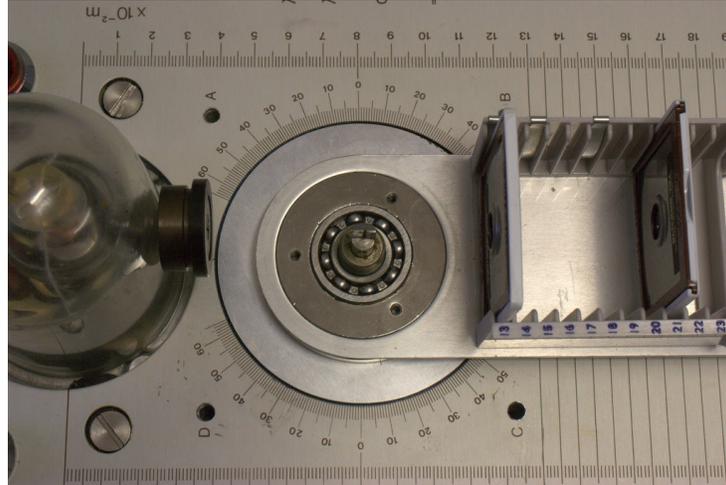
1. Remove the crystal post and jaw assembly.



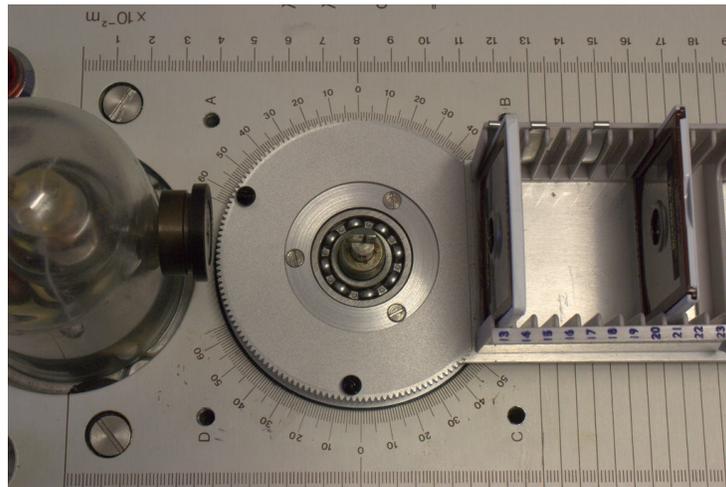
2. Remove the knurled clutch plate and four-lobed washer.



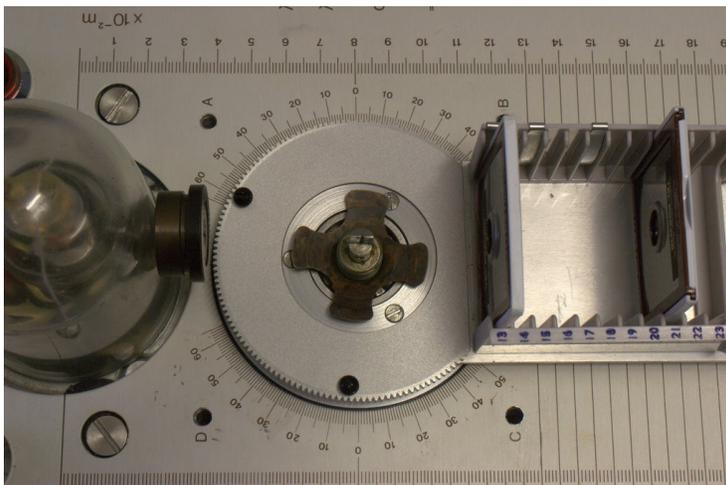
3. Remove the three screws securing the arm retainer on top of the detector arm. Remove the arm retainer.



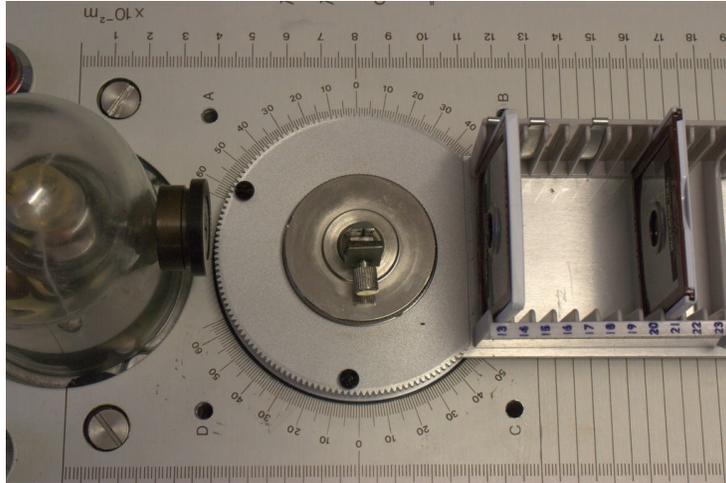
4. Install the provided gear on top of the carriage arm. Save the metal plate from step 3 in a safe place. Then, replace the three screws removed in step 3.



5. Replace the four-lobed washer. The sharp edge at the center of the washer must point down.

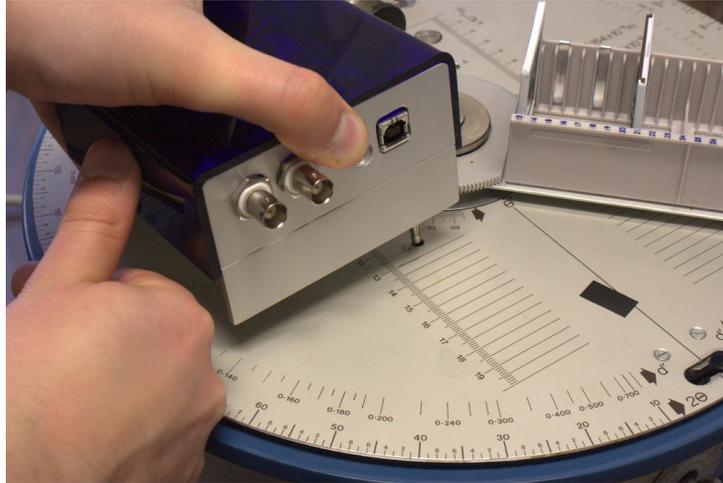


6. Replace the knurled clutch plate, crystal post, and jaw assembly.



## 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. Attach the USB cable between the computer and TEL-X-Driver.
4. Attach a GM tube to the BNC connector labeled “GM tube/PMT HV” If you are using a scintillator and PMT tube, connect the signal cable to the BNC connector labeled “PMT signal” and connect the PMT high voltage cable to the BNC connector labeled “GM tube/PMT HV”
5. 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, current monitoring, and the ability to introduce an angular offset based on the x-ray diffraction data of LiF.

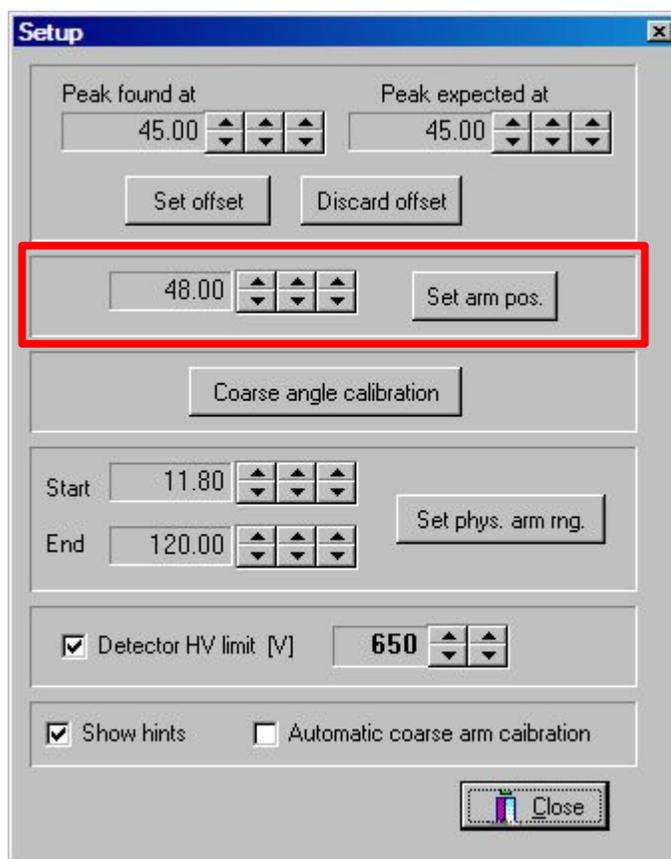
## Setup Instructions

### Basic Setup

1. Start the TEL-X-Driver control software.
2. Note the arm position (listed in the upper left corner of the screen). If this matches the actual carriage arm position, proceed to “Testing the Configuration”



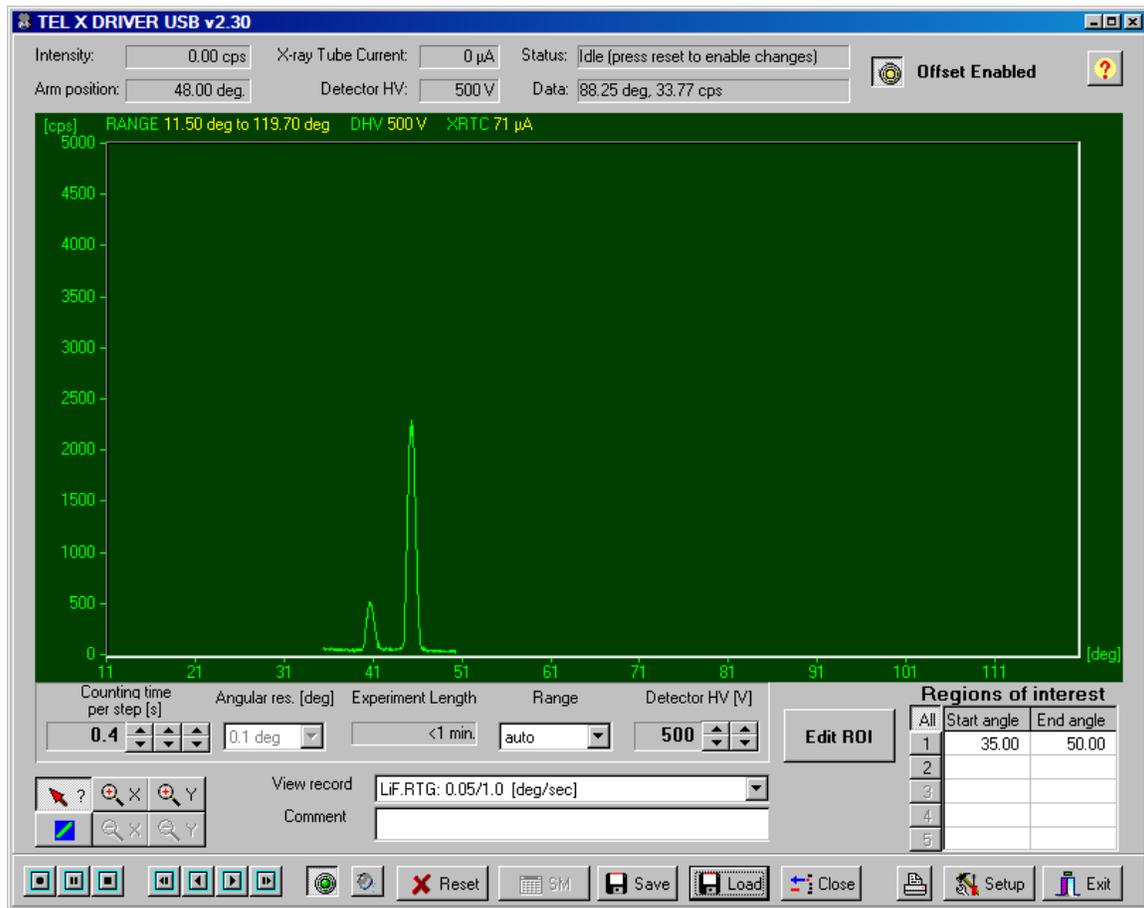
3. If the angle you noted in the previous step and the actual carriage arm position do not match, open the “Setup” window (button on lower right corner). In the “Arm Position” section, change the angle to reflect the actual position of the carriage arm and press “Set arm pos.”



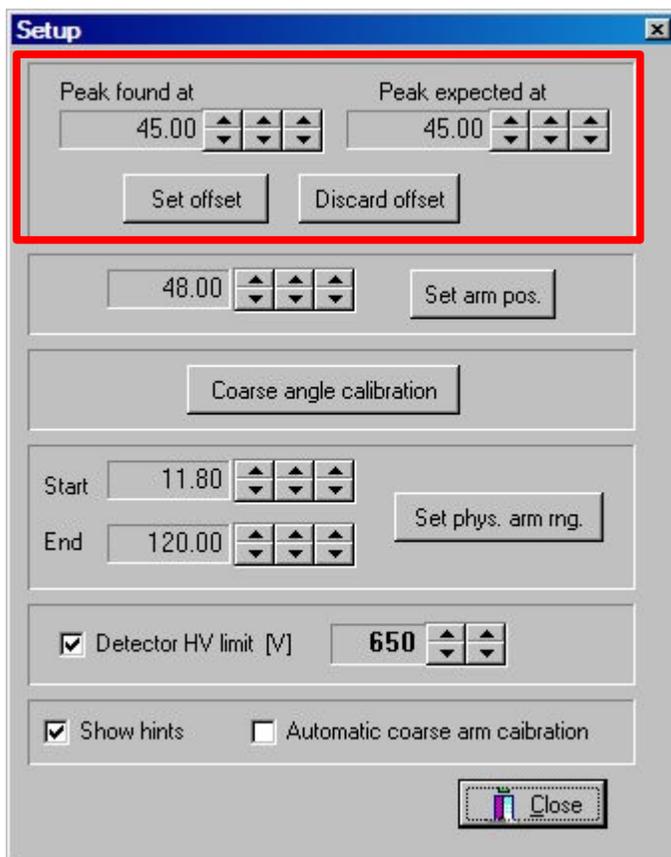
4. Close the “Setup” window.

## Testing the Configuration and Setting Angle Offset

1. Insert a LiF crystal (TEL-563.005) into the crystal post and jaw assembly 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. Click *Edit ROI* and adjust *Beginning* to  $38^\circ$  and *End* to  $48^\circ$ . Adjust the *Counting time per step* setting to .5 seconds and *Angular Resolution* to  $.10^\circ$ . Set the detector high voltage (HV) to 500V and turn the HV on. Turn the x-rays on, then click start.
3. The TEL-X-Driver will rotate the carriage arm to  $38^\circ$  and begin taking data. Once the TEL-X-Driver has completed taking data, the *Data Collection* window should look like figure below.



4. Open the Setup window and click “Set offset.” The program will use the highest point on the graph to calculate an offset. If you would like to use a different value, simply adjust the “peak found at” value before you click “Set offset.”



5. The diffraction peak of LiF and Cu K $\alpha$  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°. If you would like to calculate the offset using a different crystal, simply perform a scan and change the “Peak expected at value” in the setup window.

# Using the TEL-X-Driver

## Basic Use

1. Make sure the TEL-X-Driver hardware is correctly installed on the TEL-X-Ometer. Also make sure that the TEL-X-Driver is attached to the computer via USB cable.
2. Start the TEL-X-Driver control software.
3. Note the arm position (listed in the upper left corner of the screen). If this matches the actual carriage arm position, proceed to step six.
4. If the angle you noted in the previous step and the actual carriage arm position do not match, open the “Setup” window (button on lower right corner). In the “Arm Position” section, change the angle to reflect the actual position of the carriage arm and press “Set arm pos.”
5. Close the “Setup” window.
6. Insert a crystal into the crystal post and jaw assembly of the TEL-X-Ometer.
7. Assuming you do not know at what angle to expect diffraction peaks, use the “Regions of interest” (ROI) window to 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. If you have multiple angle regions to test, input all the regions in the ROI window.
8. Select a *Time per step* value. 0.1 seconds is sufficient for locating peaks, but a longer time, such as 1 second, will yield higher quality data.
9. 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°.
10. Set the HV to 500V, and switch both the HV and x-rays on. 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.

## Saving Data

1. Once a scan has completed, you may wish to enter information in the *Comment* section.
2. Press the *Save* button.
3. Navigate to the folder in which you want to save data.
4. Select a file format for your data. You may choose either .xrd (which can be opened by the TEL-X-Driver software) or .txt.
5. Input a file name that describes your measurement, and click *Save*.  
Data is also saved automatically in the file safety.xrd (located in the same folder as xray.exe) every 30 seconds. This insures that data will not be lost in case of computer trouble or power outage.

## Loading Data

1. Click the *Load* button.

2. Navigate to the directory in which the file you want to open is saved. Select the file and click *Open*.
3. You may now switch which file you are viewing using the “view record” drop down menu.

### **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 *powder 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 10 or 20 second *time per step* is recommended.
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.

### **X-Ray Absorption experiments**

The TEL-X-Driver mount prevents one from using the Auxiliary Slide Carriage. X-Ray Absorption experiments can still be performed. One must simply preserve the order of components, but place them all on the normal carriage arm. For example, to perform D16, one should place the slice collimator at ES12 instead of ES4, the filter (Cu, Zn, Ni, or Co) at ES14, and all other components as stated in the experimental manual.

### **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 required for experiments D10, D17 and D18.

1. Click *Scaler* on the main TEL-X-Driver window to open the *Scaler Mode* window.
2. Select your desired *Counting time*, and *Detector HV*, and turn the HV on.
3. Adjust *Rotary Radiator selection*, *Filter selection*, *Detector position*, and *Filter thickness* to reflect the experimental setup. The *Tube current* is recorded automatically when *Acquire Data* is clicked.
4. Click *Acquire Data* to begin counting. You may click *Abort* if you would like to change a setting and discard data recorded so far.
5. By changing the *Independent variable* radio button selection, one can create graphs of intensity as a function of any relevant variable.
6. The *Save* button works the same as the *Save* button on the main *TEL-X-Driver* window.

## **Performing D23/34: Mosley's law**

Experiments D16 and D17 can be performed in relatively little time using the TEL-X-Driver and the TEL-X-Ometer. The TEL-X-Driver software will automatically produce the graphs seen in the TEL-X-Ometer manual.

1. Read experiments D16 and D17 completely.
2. Remove the crystal post and clamp. Install the *rotary radiator (564.001)* on the *TEL-X-Ometer* as pictured on page 21 of the TEL-X-Ometer manual.
3. Collect the filter set, 564.002-564.009
4. Follow the instructions for experiments D16 and 17. Use the *scaler mode* to collect data for every combination of filter and rotary radiator position.
5. Save the data. Select *Mosley's law excel spreadsheet* under *save as type*.
6. Open the newly created Excel spreadsheet. All relevant graphs have been created and the data is laid out in data tables.

## **Suggested settings for experiments included in the TEL-X-Ometer manual**

| Experiment | Tube Current | Resolution      | Time | start angle   | end angle      |
|------------|--------------|-----------------|------|---------------|----------------|
| D10        | 40 $\mu$ A   | -               | 1s   | -             | -              |
| D14        | 80 $\mu$ A   | 0.1 $^{\circ}$  | 1s   | 15 $^{\circ}$ | 120 $^{\circ}$ |
| D15        | 80 $\mu$ A   | 0.05 $^{\circ}$ | 10s  | 12 $^{\circ}$ | 25 $^{\circ}$  |
| D16        | 80 $\mu$ A   | 0.1 $^{\circ}$  | 10s  | 20 $^{\circ}$ | 40 $^{\circ}$  |
| D17        | 80 $\mu$ A   | -               | 5s   | -             | -              |
| D18        | 80 $\mu$ A   | -               | 5s   | -             | -              |
| D22        | 80 $\mu$ A   | 0.1 $^{\circ}$  | 2s   | 15 $^{\circ}$ | 35 $^{\circ}$  |
| D25        | 80 $\mu$ A   | 0.05 $^{\circ}$ | 20s  | 25 $^{\circ}$ | 70 $^{\circ}$  |