Universal Scale Instruction Manual

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2D/3D finite-element software for electrostatics
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1 Main window

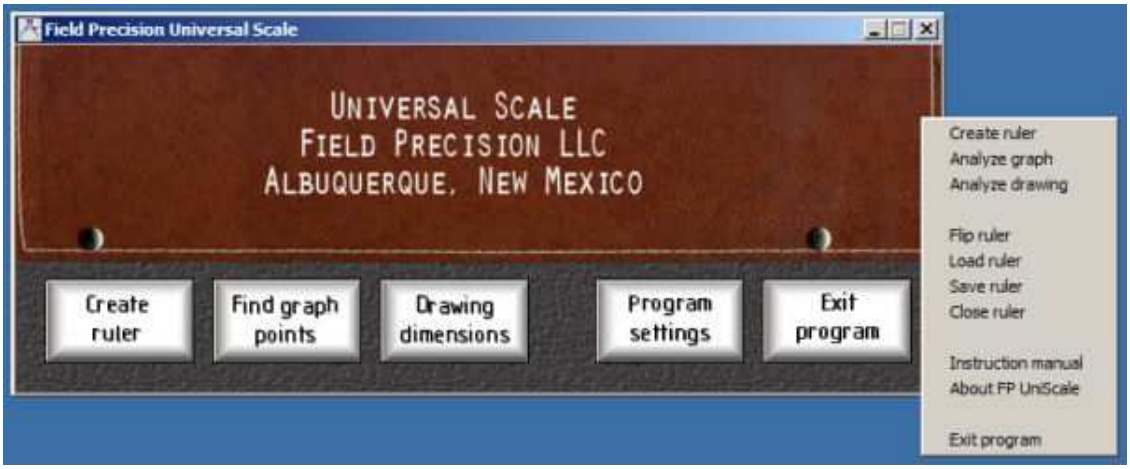

Figure 1: **Universal Scale** main window.

The **Universal Scale** is a high-accuracy spatial measurement system for image information displayed on a computer screen: graphs in reports and publications, drawings, medical images and photographs. The unique feature is that the flexible rulers and measurement templates fit the image. With the program, you can:

Create movable screen rulers calibrated to images with a choice of colors and transparency.

Save and reload rulers for standard measurements.

Measure points on graphs, even with rotations and distortions.

Find coordinates and dimensions of mechanical drawings and diagrams.

Quickly digitize graphed curves.

Transfer numerical information to other applications via the clipboard or data files.

The main window (Fig. 1) appears when you start the **Universal Scale**. The controls include five pushbuttons and a popup menu called by clicking the right mouse button. Press `F1` to open this instruction manual. The first three buttons activate the primary functions of the program:

Create movable, calibrated screen rulers.

Measure points and curves on graphs in publications and reports.

Find coordinates and dimensions on drawings and diagrams.

Use the `Program settings` button to set the color and transparency of new rulers. The popup menu includes commands to control the current ruler. They are discussed in the next section.

2 Create ruler window

Figure 2: Create ruler window with a calibration setup.

Click the `Create ruler` button in the `Main` window to open the window shown in Fig. 2. Note the contextual instruction box at the bottom. If you use the **Universal Scale** infrequently, there's no need to worry about forgetting procedures.

Before discussing controls and options, let's run through the steps involved in making a screen ruler. The illustration shows a typical application. We have an image (in this case, a bedbug and a nymph) with a reference object. The first step is to supply values for the calibration length (the diameter of a penny is 19.05 mm) and the desired length of the ruler (20.0 mm). Then, click the leftmost toolbar button (`Create a new ruler`). The program opens a calibration screen (effectively a sheet of tracing paper). Move it and resize it to span the reference object. Position the special calibration cursor on the left side of the object using the mouse or the arrow keys. Then click the left mouse button or press the `F1` key. Then move to the right side and click the left button (or press the `F1` key). The ruler instantly appears, as shown in Fig. 3. You can drag it anywhere on the screen by moving the mouse over the ruler and holding down the left button.

That's all there is to it! Now let's fill in some details. If the reference interval is oriented in the vertical direction, the program creates a vertical ruler as shown in Fig. 4. You can change the appearance of new rulers by clicking the `Settings` dialog in the main window. The ruler shown in Fig. 4 uses the `Black on yellow` color scheme with `High transparency`. Note the

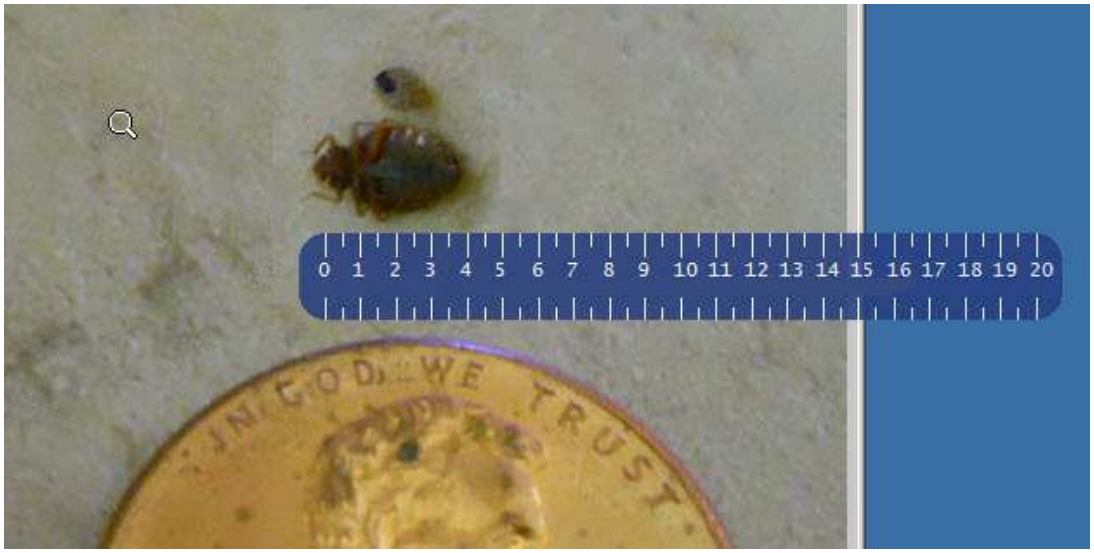

Figure 3: Ruler created with the setup of Fig. 2.

multiplication factor printed on the ruler (×1000). The 2000 foot ruler was created to measure the height of buildings near the Willis Tower (1,729 ft at the top of the antennas). The program picks the number of tick marks based on the pixel resolution of the ruler. There is no point including a large number of ticks if they are irregularly spaced.

The toolbar buttons have the following functions:

`Create new ruler`. Open a calibration screen to define a new ruler. You can have two rulers active at any time. Before clicking the button, be sure to fill in values for the length of the calibration object and the total length of the ruler. Move the calibration screen so that it encloses the calibration object and then left-click twice to define a horizontal or vertical interval.

`Flip ruler`. Toggle the currently-active ruler between horizontal and vertical. If you have two rulers on the screen, the active one is the last one moved. Measurements with a flipped ruler are valid if you are analyzing a raster image and if the pixel spacing on your monitor is the same in both directions (usually the case for LCD monitors). Otherwise, you should create two calibrated rulers for horizontal and vertical measurements.

`Close ruler`. Delete the currently-active ruler.

`Save ruler`. Save the currently-active ruler for later use. This is a useful feature if you are analyzing several images with the same calibration. Supply a descriptive name in the dialog. The ruler is saved as a `PNG` file.

`Load saved ruler`. Open a dialog to load a saved ruler. If a single ruler is open on the screen, the saved ruler is added. Otherwise, it replaces the currently-active ruler. To view snapshots of the saved rulers, set the `View` option in the open dialog to `Large icon` or `Extra large icon`. You can also use this dialog to delete unused rulers. Right click on the ruler and choose `Delete`.

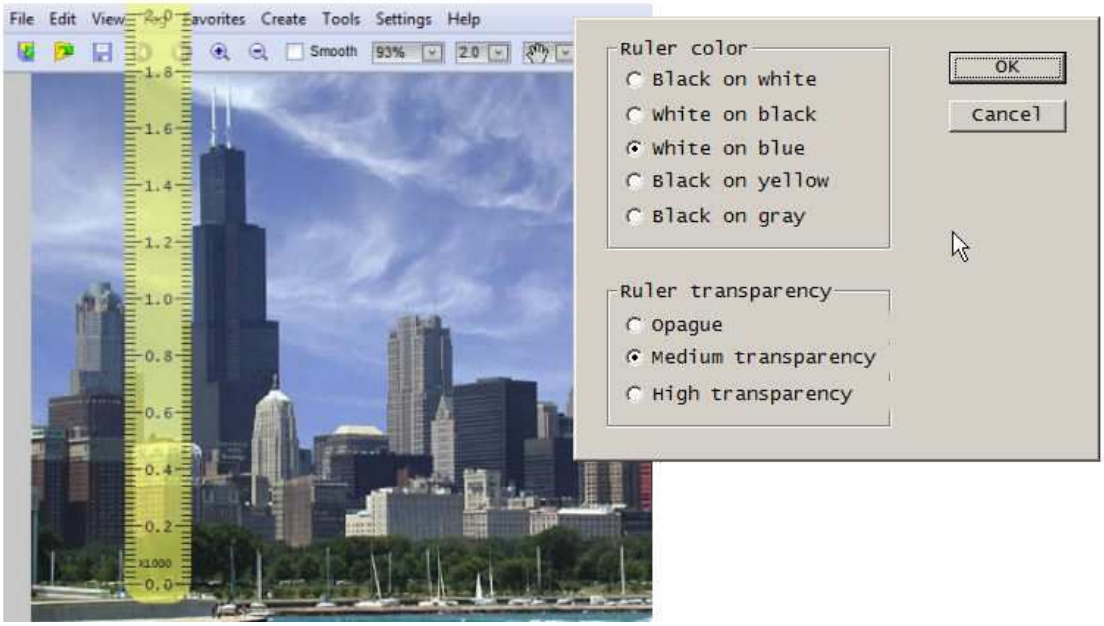

Figure 4: Program settings dialog and an example of a vertical ruler with high transparency and a multiplication factor.

`Instructions`. Display online instructions.

`Close this window`. Close the `Create ruler` window. The window need not be open to use screen rulers.

Most ruler commands may be issued from the `Main` window using keyboard shortcuts or the popup menu. The `Main` window supports the following keyboard shortcuts:

`CTLR-Q`. Exit the program

`CTRL-F`. Flip the current ruler (horizontal/vertical)

`CTRL-S`. Save the current ruler

`CTRL-C`. Close the current ruler

`CTRL-O`. Open a saved ruler

3 Measure graph points window

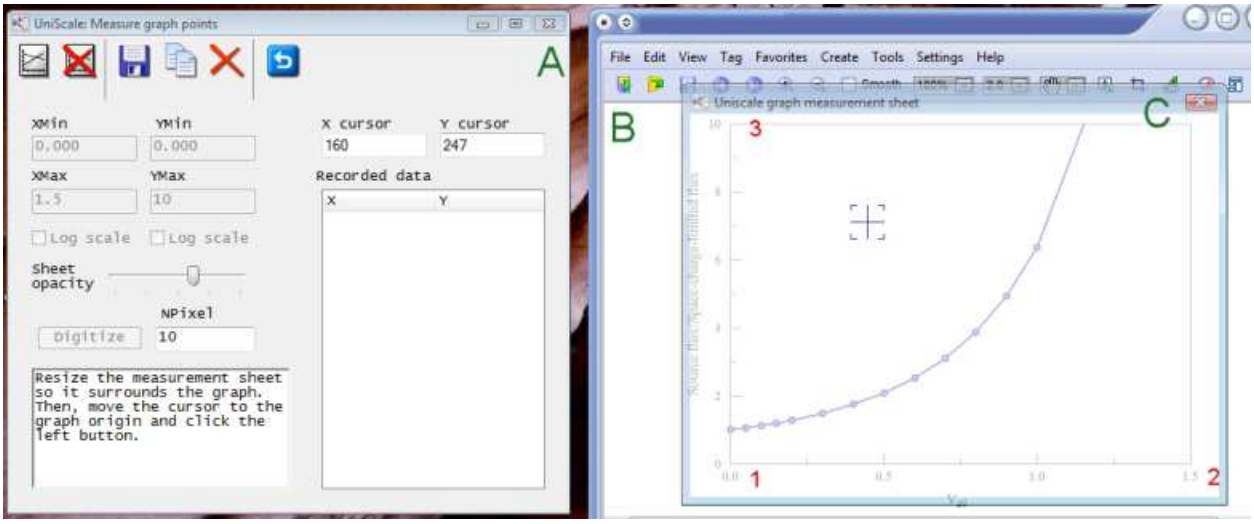

Figure 5: `Find graph points window` with a setup for calibration and measurements.

Click the `Find graph points` button in the `Main` to open the window marked as A in Fig. 5. The function is to extract quantitative information from graphs displayed on your screen. With the high pixel resolution of modern monitors, you should be able to achieve accuracy better than 1%. Again, let's start by following an example.

The object marked B in Fig. 5 is any other program on your computer that displays graphical information (for example, a `PDF` viewer, word processor, photo editor,...). The example graph has limits 0.0 to 1.5 along the abscissa (x axis) and 0.0 to 10.0 along the ordinate (y axis). The first step is to supply numerical values in the $XMin$, $XMax$, $YMin$ and $YMax$ boxes. Then click the leftmost toolbar button (`Open measurement sheet`). The program creates a translucent measurement sheet (marked C). Move and resize it so that it covers the graph. You can adjust the opacity for the best view.

The next step is to calibrate the sheet. Move the calibration cursor to the origin (point *1*) and click the left button. (As you move the mouse, the pixel coordinates are displayed in the `X cursor` and `Y cursor` boxes.) Then, move the cursor to the end of the abscissa (point *2*) and click the left button. Finally, move to the top of the ordinate (point *3*) and click the left button. The measurement sheet locks when calibration is complete. There are four characteristics of the locked state:

A reference blue line grid is added to confirm the calibration.

The cursor changes to the measurement symbol.

Absolute graph coordinates are displayed in the `X cursor` and `Y cursor` boxes.

The measurement sheet cannot be moved or resized.

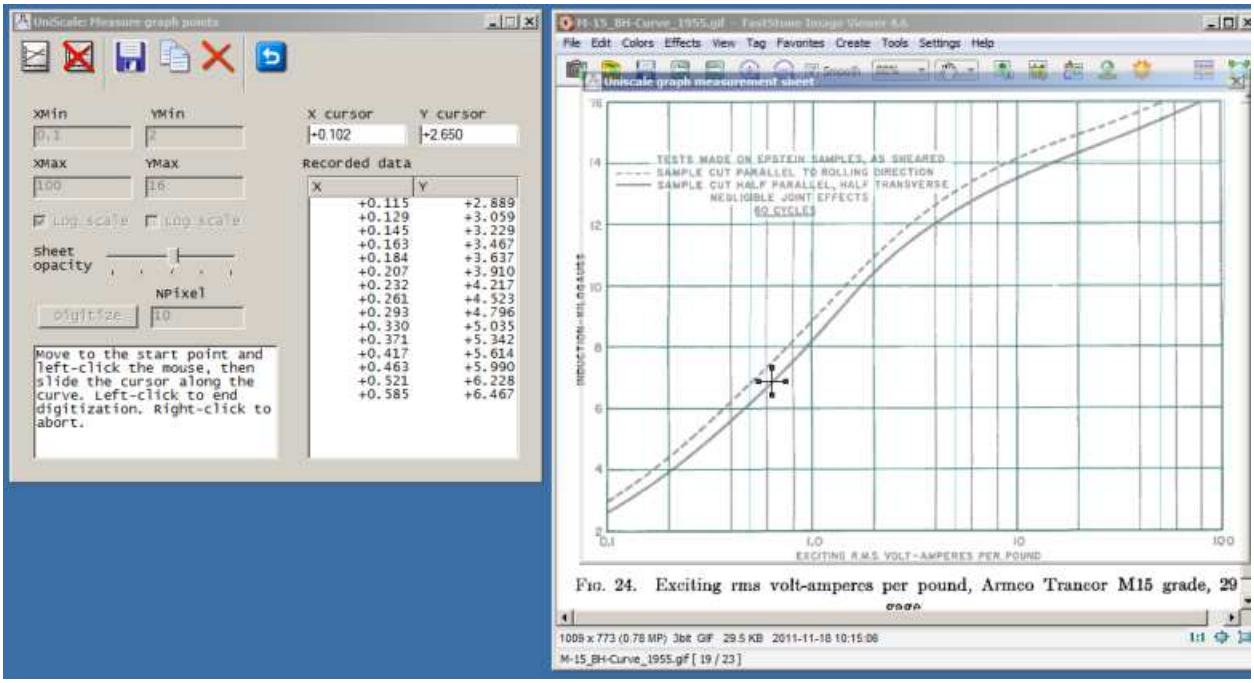

Figure 6: Calibration setup for a graph with a logarithmic axis, digitization in progress.

We're now ready to take measurements. Move the cursor over a point and click the left button to record numerical data. Each set of values is displayed in the `Recorded data` list box and copied to the clipboard in CSV (comma-separated variable) format.

The toolbar buttons of the `Measure graph points` window have the following functions:

`Open measurement sheet`. Click this button to open a measurement sheet after you supply values of $XMin$, $XMax$, $YMin$ and $YMax$.

`Close measurement sheet`. Close the current measurement sheet to analyze a different graph.

`Save data to file`. Save the contents of the `Recorded data` list box to a file in CSV format.

`Copy data to clipboard`. Copy the contents of the `Recorded data` list box to the clipboard in CSV format for transfer to spreadsheets and other data programs.

`Clear data`. Clear the contents of the `Recorded data` list box.

`Instructions`. Display online instructions.

`Close this window`. Close the current window and measurement sheet. Note that the `Measure graph points` window must be closed in order to use the `Measure drawings window`. Activities in this window do not affect screen rulers.

This section concludes with a list of additional features and properties of the `Measure graph points` window:

1. When making accurate measurements, it is often difficult and frustrating to maintain the mouse at an exact screen position, especially when you click a button. The **Universal Scale** has keyboard functions to help. To set an precise position, move the cursor close to the desired location with the mouse and then use the arrow keys to fine-tune the position one pixel at a time. You can press the `F1` key instead of the mouse button for any operation that requires a left click.

2. Values entered in the `XMin`, `XMax`, `YMin` and `YMax` boxes may be in any real-number format (1.25, 500, 2.5E8, ...). The numerical display automatically switches to scientific notation for very large or very small ranges.

3. Use the check boxes if the graph contains one or more logarithmic axes (Fig. 6). In this case, values in the `XMin-XMax` and/or `YMin-YMax` boxes must be greater than 0.0.

4. The **Universal Scale** uses a generalized trapezoidal coordinate system for graph analysis. This means that you can often get useful information from bad scans (rotations and distortions). Use the blue line grid to check the fit.

5. If you make a mistake in a stage of the calibration process before the measurement sheet is locked, you can go back one step by clicking the right mouse button or using the `ESC` or `CTRL-Z` key. If there is a problem after the sheet is locked, close it and repeat the calibration.

6. The program adjusts for inverted graphs, where $x_{min} > x_{max}$ and/or $y_{min} > y_{max}$.

7. To digitize curves like the one in Fig. 6, push the `Digitize` button. Then move the cursor to the start point of the curve on the locked measurement sheet. Click the left button and slide the cursor along the curve. Values appear in the `Recorded data` list box. When you reach the end of the curve, be sure to left or right-click the mouse to terminate the digitization process. The value in the `NPixel` box is the approximate distance in pixels along the curve between points. Lower the number to record more points.

4 Measure drawings window

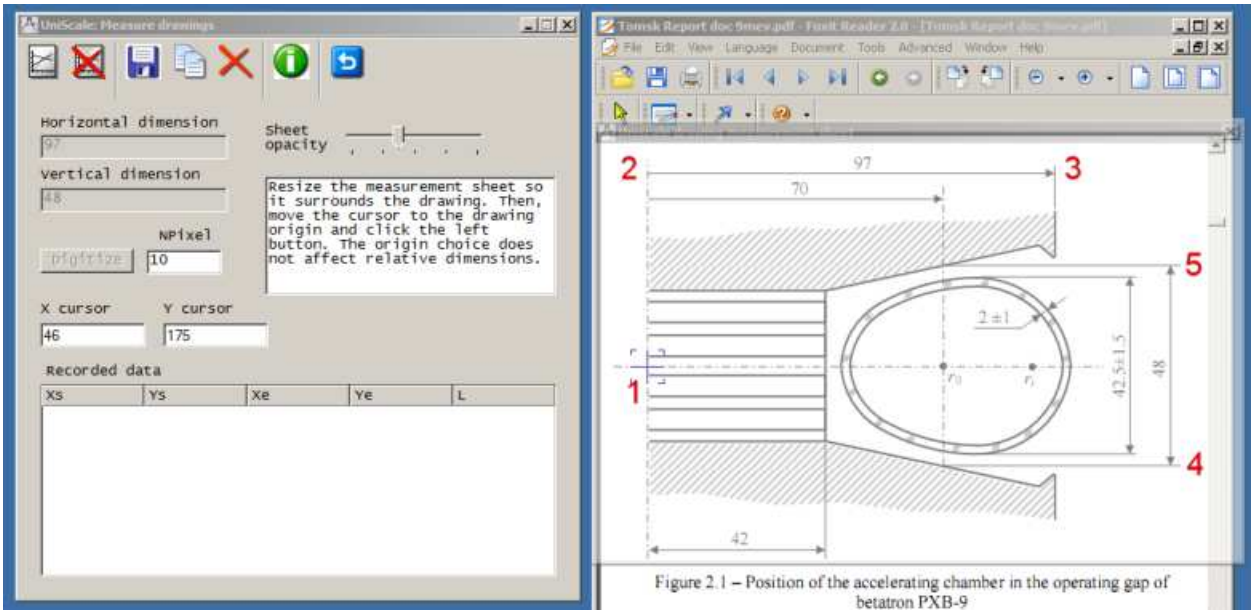

Figure 7: Drawing calibriation procedure.

Click the `Drawing dimensions` button in the `Main` window to enter the `Measure drawings` window shown in Fig. 7. The functions of this window are useful if you have a mechanical drawing or scaled diagram in a non-CAD format (e.g., `PDF`). With the **Universal Scale**, you can get good approximations for coordinates and dimensions.

To start, supply reference dimensions for the horizontal and vertical directions (97.0 cm and 48.0 cm in the example). Then, click the leftmost button on the toolbar to open a measurement sheet. Move and resize the sheet so that it covers the drawing. To calibrate the measurement, left click the mouse at the following positions:

The origin. The choice affects absolute coordinates but does not affect relative dimensions.

The start point of the horizontal reference dimension. (Here, the vertical position of the cursor is not critical).

The end point of the horizontal reference dimension.

The start point of the vertical reference dimension. (The horizontal position of the cursor is not critical).

The end point of the vertical reference dimension.

The sheet locks when all points have been entered. The cursor changes to the measurement style and the program creates a blue line grid with convenient intervals. If you make a mistake,

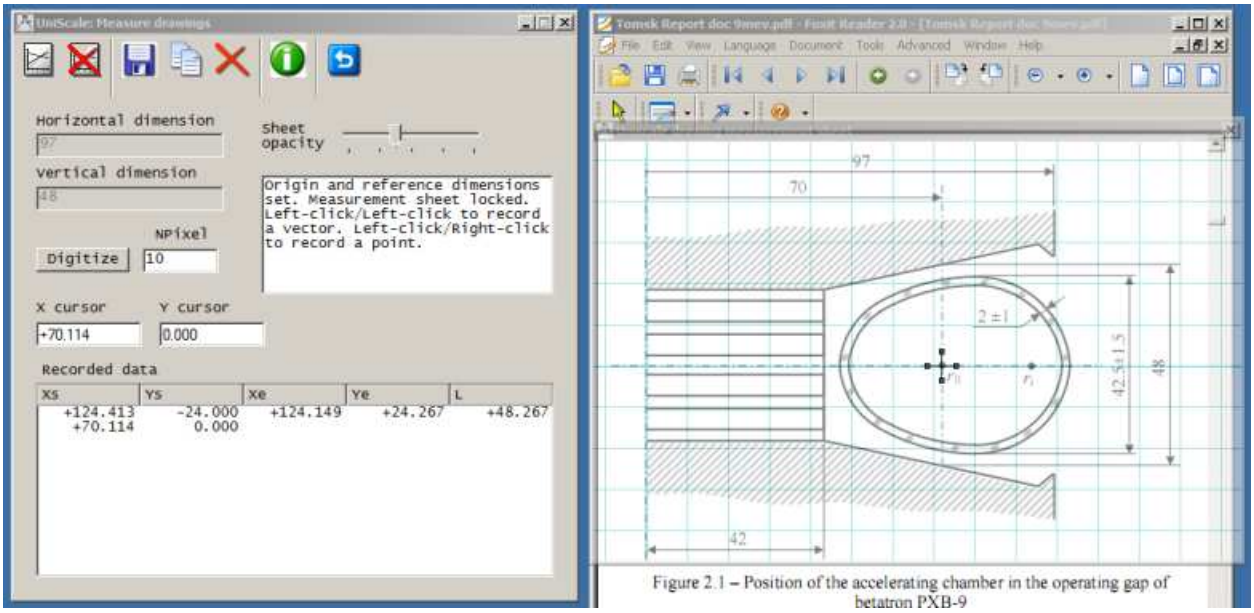

Figure 8: Taking drawing measurements in the locked mode.

you can go back one step by clicking the right mouse button or pressing the `ESC` or `CTRL-Z` keys.

In the locked mode (Fig. 8), the `X cursor` and `Y cursor` boxes show calibrated coordinates relative to the origin. To add a vector to the `Recorded data` list box, left-click the mouse at the start point and then left-click at the end point. The first list box entry in Fig. 8 shows the data: the start and end points and the vector length. To save the coordinates of a single point, left-click the mouse at the point and then right-click anywhere.

The buttons in the toolbar serve the same functions as those in the `Measure graph points` window. Here are some additional features and properties of the `Measure drawing` window:

As in the `Measure graph points` window, you can use the arrow keys to fine-tune the cursor position after moving close with the mouse. Pressing the `F1` key is an option for any operation that involves clicking the left mouse button. The `F2` button may be used instead of the right mouse button (*e.g.*, record coordinates of a single point).

In contrast to the `Measure graph points` window, the program does not handle rotated or distorted drawings. The idea is that measurements on such drawings would probably be misleading.

If you are certain that objects displayed on your monitor have the same scale in the horizontal and vertical dimensions, you can enter a single dimension in the Horizontal dimension or Vertical dimension box and leave the other one blank. In this case, the calibration procedure is shortened. On the other hand, if you have horizontal and vertical reference objects available, the safest approach is to calibrate both axes.

The `Digitize` button is useful if you want to find a sequence of coordinates to approximate a curved surface. Press the button, move the mouse to the start of the curve and left-click. Left-click for more points or right-click to terminate the record or coordinates.

The `Measure drawings` window must be closed in order to use the `Measure graph points` window. Activities in this window do not affect screen rulers.