PLOTTING WITH ERROR BARS

Thanks to Ben Zwickl for the information in this document. More information is available on the Advanced Lab website: http://www.colorado.edu/physics/phys3340 .

ERROR BARS

The error bar is a graphical way to display the uncertainty in a measurement. In order to put error bars on a plot you must first estimate the error for each point. Anytime you include error bars in a plot you should explain how the uncertainty in each point was estimated.

ERROR BARS IN MATHEMATICA

Creating plots with error bars in Mathematica requires the use of the `ErrorBarPlots` package. Suppose you had estimated the uncertainty at every point in the measurement of photodiode amplifier voltage versus position across some light beam to be 0.04 V. This error was chosen to demonstrate the mechanics of making a plot with error bars, but the uncertainty in the actual data was probably smaller than this. Also, there is no reason to believe it was the same at low and high voltages. The data and uncertainty form a three column data set now.

Micrometer Position (inches)	Photodetector Voltage (V)	Estimated uncertainty (V)
0.410	0.015	0.04
0.412	0.016	0.04
0.414	0.017	0.04
0.416	0.026	0.04
0.418	0.060	0.04
0.420	0.176	0.04
0.422	0.460	0.04
0.424	0.849	0.04
0.426	1.364	0.04
0.428	1.971	0.04
0.430	2.410	0.04
0.432	2.703	0.04
0.434	2.795	0.04
0.436	2.861	0.04
0.438	2.879	0.04
0.440	2.884	0.04

The Mathematica code for plotting with error bars will look something like this:

```
Needs["ErrorBarPlots`"];
d = Import["Gaussian_beam_data_with_errors.txt", "TSV"];
dNew = Table[{ {d[[i,1]], d[[i,2]]}, ErrorBar[d[[i,3]]]
  },{i,2,Length[d]}];
ErrorListPlot[dNew,
     FrameLabel->{"Position, x (inches)", "Photodetector output (V)"}]
```

The first line loads the `ErrorBarPlots` package. The second line is important because the error bars have to be input in a certain format. The following table gives a comparison of plotting data with and without error bars in Mathematica.

No error bars	With error bars

`d = {{x1,y1}, {x2, y2}, ...}`	`d = { {{x1, y1}, ErrorBar[e1]},`
	`        {{x2, y2}, ErrorBar[e2]},`
	`        ...}`

(built in function)	`Needs["ErrorBarPlots`"];`
`ListPlot[d]`	`ErrorListPlot[d]`

EXAMPLE: GAUSSIAN LASER BEAM WIDTH MEASUREMENT