GRAFFER — A flexible electronic graph paper
Version 1.03

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Contents

1 Introduction

The original idea for GRAFFER goes back some considerable time. It arose from the frustration at the lack of any utility to fill the gap between xfig and writing an application-specific program to plot the data. Its primary function is the generation of X-Y plots and annotating them; in other words, to fill that niche occupied in the dark ages[1] by *graph paper*. Unlike real graph paper it is easy to switch from linear to logarithmic plots, to change scalings, to change and move annotations or to adjust points. It's also easy to save the plot so that it can be incorporated into other packages (e.g. xfig or LaTeX).

1.1 Requirements

GRAFFER is written in IDL and requires at least version 4.0.1 to be able to operate[2]. A terminal or workstation supporting IDL widgets is needed, with a sufficiently large screen to hold the main GRAFFER control window which using Motif widgets on my workstation is about 900 pixels in the y-direction which is likely to be the critical dimension. You will also need a 3-button mouse or something which emulates one.

Although it should work on anything which supports IDL with widgets, testing has been done using IDL 4.0.1 on a Sparc-5 running Solaris 2.4.

2 Using GRAFFER

2.1 Starting up

To run GRAFFER it is necessary to have the directory with the GRAFFER routines in your !PATH variable in IDL. There are two ways to do this, either by adding the directory to the !PATH explicitly within IDL, e.g.:

```
IDL> !path = '/datan8/sjt/graffer/:'+!path
IDL> graffer
```

or by adding the path to your IDL_PATH environment variable[3], e.g.:

```
xuna> setenv IDL_PATH '/datan8/sjt/graffer/:+/datana/idl/lib/'
xuna> idl
.
.
IDL> graffer
```

[1] When a dumb terminal cost as much as a workstation now does and most users had to work on teletypes.

[2] The only feature which I believe to be version-4 dependent is the use of tracking events—the package should work, apart from the function description window under version 3.6

[3] If using this method note that the IDL_PATH environment variable must be set to the whole path that is to be used, not just the extra path items (see the IDL documentation for more details).

Once you are in IDL with !PATH correctly set, then to start up GRAFFER give the command `graffer`. `graffer` takes a single optional string argument specifying the filename to use this may either be a pathname or a simple filename in which case the current directory is used. If no filename is given, then a `pickfile` menu appears to allow you to select a file or specify a file name. In addition to the argument, there are four keywords that may be given:

XSIZE : Specify the X-dimension of the display window in pixels (the default is 600). Values less than 600 are ignored, for greater values, the display window is created as a scrollable window.

YSIZE : The same for the Y-dimension.

GROUP : The group leader of the widget hierarchy, only used when GRAFFER is invoked by another widget.

DEBUG : If this is set and non-zero, then run GRAFFER in debug mode (information level messages are enabled and it doesn't return to the caller on a crash)[4].

Examples of ILLEGAL GRAFFER calls:

```
IDL> graffer test.grf                   ; No comma after command name, no
IDL>                                    ; quotes around file name

IDL> graffer, 'test.grf', 800, 800      ; too many arguments

IDL> graffer, debug                     ; DEBUG is a keyword (this would
IDL>                                    ; be valid if DEBUG were a string
IDL>                                    ; variable containing a filename)
```

What was probably meant is:

```
IDL> graffer, 'test.grf'                ; Comma after command name,
IDL>                                    ; quotes around file name

IDL> graffer, 'test.grf', xsize=800, ysize=800
IDL>                                    ; X and Y sizes given as keys

IDL> graffer, /debug                    ; Start graffer in debug mode
```

2.2 A quick tour of the main GRAFFER window

Now that you've got GRAFFER up and running, you should see the main GRAFFER window dominating your screen. Before going into the details of how to use it, let's just make a quick tour of the main areas of the window and what they do.

[4] Under normal circumstances I should be the only person who needs to use this.

The most obvious item should be the *plotting panel* in the upper-right quadrant which will contain a basic set of axes (assuming you've started up with a new file). This is where the plot will be displayed. It is also possible to enter data and select the location for text using the cursor and mouse in the plotting window.

To the left of and below the plotting window are a selection of buttons and entry windows that allow you to control the plot. The simplest thing is to go over these from top to bottom.

Right at the top comes the *utility control menu*, this is a pull-down menu which allows you to get out of `GRAFFER`, to make hardcopies, save files or open new ones. Below this are two text windows which display the name of the current file and the current directory, these are not writable by the user.

Beneath this comes the *general settings* panel, which has entry windows for settings affecting the whole plot. The general settings panel is followed by two essentially identical *axis settings* panels, one for each axis, which allow you to set the properties of the axes (e.g. range, log or linear etc.).

Underneath these and extending under the plotting window is the *dataset control*, which also includes some items which don't fit anywhere else. The detailed layout of this panel is liable to change from version to version and the descriptions here apply to Version 1.03. Working from left to right, you will see firstly the buttons for selecting the dataset on which to operate, and below it the current cursor position. To the right of this are various buttons and entry boxes to set the properties of the current dataset, with underneath a message window for any warning or error messages from `GRAFFER`. At the far right are buttons for accessing the various ways of setting the data in the current data set and the text/data mode selector button.

Right at the bottom of this lower panel is the "function" window which displays a brief description of the function of the object currently being pointed at with the mouse.

3 X-Y data

The principal function of `GRAFFER` is to allow you to make plots of Y *vs.* X data, therefore it seems logical to make that the first detailed topic of this manual.

`GRAFFER` supports the plotting of multiple plots on a single set of axes, each plot is referred to as a *data set*. All data plotting operations act on the *current* data set.

3.1 Entering data

There are seven ways to enter data:

With the mouse: To enter a datum using the mouse, move the cursor to the desired location (if cursor tracing is enabled the current location will be displayed in the location windows in the lower left of the screen and continuous cross hairs will be displayed from the cursor location to the axes). When the cursor is where you want it click with the *LEFT* mouse button, the cursor location will then be added to the current data set. To move a datum, move the cursor near to the point to be moved then press

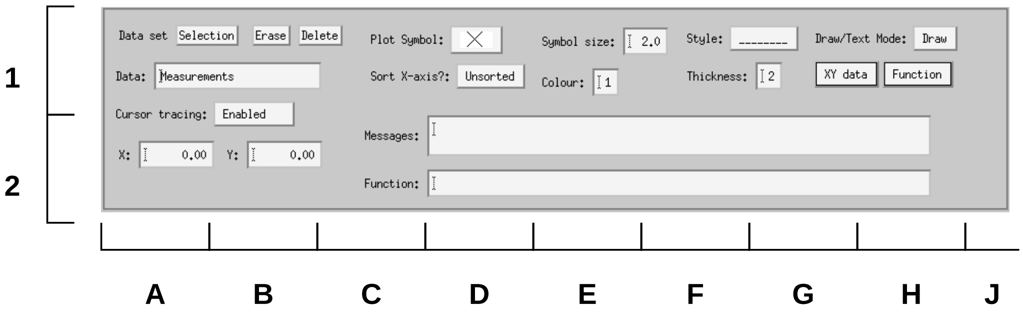

FIGURE 1: *The lower panel of the main* GRAFFER *control window. The "rulers" on the sides of this and other figures are used when a reference is made to a button e.g.* FIG. 1(D1) *would refer to one of the buttons in the coordinate box (D1).*

the *CENTRE* button, slide the cursor to the required location and then release the button. To delete a datum, move the cursor close to the datum to be deleted and click on the *RIGHT* mouse button, to prevent accidental deletion of some remote point by clicking on a random piece of screen the cursor must be within a radius of 5 pixels of the datum.

For mouse-entered data, it is NOT possible to provide error bars, and data with error bars cannot be edited or deleted with the mouse.

Observational data: There are three ways (other than with the mouse) to enter observational data. These are all accessed via the *XY data* pull down menu (FIG. 1(G1)):

From a file: To enter data from a file, first create a file containing the data set. This should be formatted such that each (x, y) pair is on one line. Then select the *From file ...* option of the *XY Data* pull-down which will generate a `PICKFILE` widget which is used to select the file. N.B. this method will replace the data in the current data set.

To add *symmetric* error bars add a third column to the file with the error limits, error bars will then be placed on each point. For *asymmetric* error limits, add the lower error in the third column and the upper limit in the fourth. e.g. a datum at $x = 0$ with a value of 1.0 ± 0.1 should be entered as `0 1.0 0.1`, while a value of $1.0^{+0.2}_{-0.1}$ would be `0 1.0 0.1 0.2`.

From the Data Editor: To enter or edit data using the data editor, use the *Edit values ...* option of the *XY data* pull-down. This will generate a text widget in which the data of the current data set (if there are any) will be displayed. These data can be edited using the usual text widget operations. As with a file, the data should be entered as one (x, y) pair per line. To apply the changes click on the *Do it* button, to cancel them and keep the original data set, click on the *Cancel* button. The rules for adding error bars are the same as for data from a file.

From the IDL main program level: To get variables from the main program level of IDL use the *Top level variables ...* option of the *XY data* pull-down. This will generate a pop-up menu with four entry boxes, for the X and Y values and optionally for error limits; the X and Y values must be given. To use symmetrical error bars enter the variable with the errors as the *Lower error*. Slices of variables may be used (e.g. `X(0:7)`) but functions are not allowed. All variables must have the same number of elements. If the given variables do not give a valid dataset, then an error message is generated when you click on the *Do it* button and the pop-up is not destroyed.

Functions: Functions are a special form of data set. A function is entered or edited via the *Function* pull-down (FIG. 1(H1)). There are three kinds of function which can be used, all of which use very similar function editors:

Y as a function of X : Use the *y = f(x) ...* option to produce the function editor. The function editor contains a single text widget in which to enter the function, this must be a valid IDL expression, using `x` as the independent variable, any IDL functions or system variables may be used. Examples of valid functions are:

```
sin(x)
cos(x*!dtor)
exp(-x^2)
x/total(x)
replicate(1.25, n_elements(x))
```

Note the last case, this is needed as the y values are generated as an array via the `EXECUTE` function and just entering `1.25` would not return an array.

X as a function of Y : Use the *x = f(y) ...* option to produce the function editor. The editor is identical except that now you must use `y` as the independent variable.

X and Y as a function of a third variable (parametric function): Useful for functions with loops in them. Use the *x = f(t) & y = g(t) ...* option to produce the function editor. This function editor differs in having two windows for the functions, one for the X function and one for the Y function. In each of these you must enter the function using `t` as the independent variable.

There are three further text widgets, two to set the limits of x, y or t over which the function is to be evaluated (if these are equal then the whole range of the plot is used—this is not valid for parametric functions), this allows you to draw the function over only part of the plot range (possibly because it's not defined everywhere). The final window allows you to set the number of function evaluations to be made, if this is too small the plot will look ragged, if it's too big updating the plot will become slow, it may be useful to set a low point count while drawing the figure and then increase it before you make the final copy.

There are the usual *Do it* and *Cancel* buttons to exit.

Because the method of storage is different the function and X-Y editors display a warning message and allow you to escape without destroying your data set if you inadvertently try to apply them to the other type of data set.

3.2 Display style

Most of the IDL style options for plot traces are available. These are set with the various entry windows and pull down menus below the plot window.

Plot Symbol: (FIG. 1(D1)) The symbol to use for plotting the points. The pull down menu has images of the symbols, and displays the current one on the undisturbed button. The default is `psym=0`, i.e. a continuous plot.

Symbol size: [5] (FIG. 1(E1)) The size to use for the plotting symbols, as a multiple of the default size. This is ignored for continuous or histogram plots. Any floating point value is accepted.

Line style: (FIG. 1(F1)) Line style to use for continuous plots, ignored for discrete symbols. The pull down menu shows the available styles.

X-axis sorting: (FIG. 1(D1)) For continuous plots, it is possible to request that `GRAFFER` sort the x-axis points into ascending order before plotting them. This is controlled by a 2-valued pull down menu. Obviously it has no visible effect if discrete symbols are in use.

Line thickness: (FIG. 1(G1)) The width of the line in terms of the basic line width. Enter any integer (≤ 100) to set the width. This is used both for continuous plots and for discrete symbols.

Colour: (FIG. 1(E1)) An integer value from 1-15 (0 is background) the corresponding colours are listed in Table 1.

3.3 Multiple data sets

As mentioned above, `GRAFFER` supports multiple data sets on a single plot, up to a maximum of $2^{31} - 1$ (if you can keep track of that many you're doing pretty well). Selecting a new current data set is accomplished by clicking on the *Selection* button (FIG. 1(A1)) on the left side of the panel below the plot window. This will produce a menu of all the current data sets, plus one more labelled `<new>`. The serial number, number of points, type and description of the data sets are displayed. The type codes are defined in Table 2. To make a selection, just click on it, to abandon and leave the current selection unchanged click on *cancel*.

The data set description is not used by `GRAFFER` in any way, it is just to allow you to identify data sets. To change it, just enter the value in the window immediately below the *Selection* button (FIG. 1(A1)).

The current data set can be deleted altogether by clicking on the *Delete* button (FIG. 1(B1)). For safety, this generates a confirm menu before deleting the data set. To erase the contents of a data set use the *erase* button (FIG. 1(B1)), this leaves the data set in the list but clears all the data from it—its properties are retained.

[5] The symbol size also determines the length of the caps on error bars.

TABLE 1: *Colours available in* GRAFFER

Index	Red	Green	Blue	Colour
0	255	255	255	White (BG)
1	0	0	0	Black
2	255	0	0	Red
3	0	255	0	Green
4	0	0	255	Blue
5	0	255	255	Cyan
6	255	0	255	Magenta
7	255	255	0	Yellow
8	255	127	0	Orange
9	127	255	0	
10	0	255	127	
11	0	127	255	
12	127	0	255	
13	255	0	127	
14	85	85	85	Dark grey
15	170	170	170	Light Grey

TABLE 2: *The* GRAFFER *dataset type codes*

Code	Value	Description	Code	Value	Description
XY	0	X-Y data, no errors	F(X)	-1	Function of X
XYE	1	X-Y data, symmetric errors	F(Y)	-2	Function of Y
XYEE	2	X-Y data, asymmetric errors	PF	-3	Parametric function
	–	No data set defined			

4 General properties

4.1 Overall settings

The first two editable text windows on the left hand panel of the main GRAFFER menu are fairly simple, they allow you to set a title for the plot (FIG. 2(B4)) and also a subtitle[6] (FIG. 2(B4)).

The other two items in the *General* section are: firstly, the character size setting (FIG. 2(B5)), which sets the character size for the plot annotations in terms of the default value, this is a floating-point value. The second (FIG. 2(E5)) is the line thickness to be used for drawing the axes, this is an integer value.

The pulldown toggle to select cursor tracing is located in the bottom panel (FIG. 1(B2) for reasons of

[6]The former goes at the top, while the latter goes at the bottom.

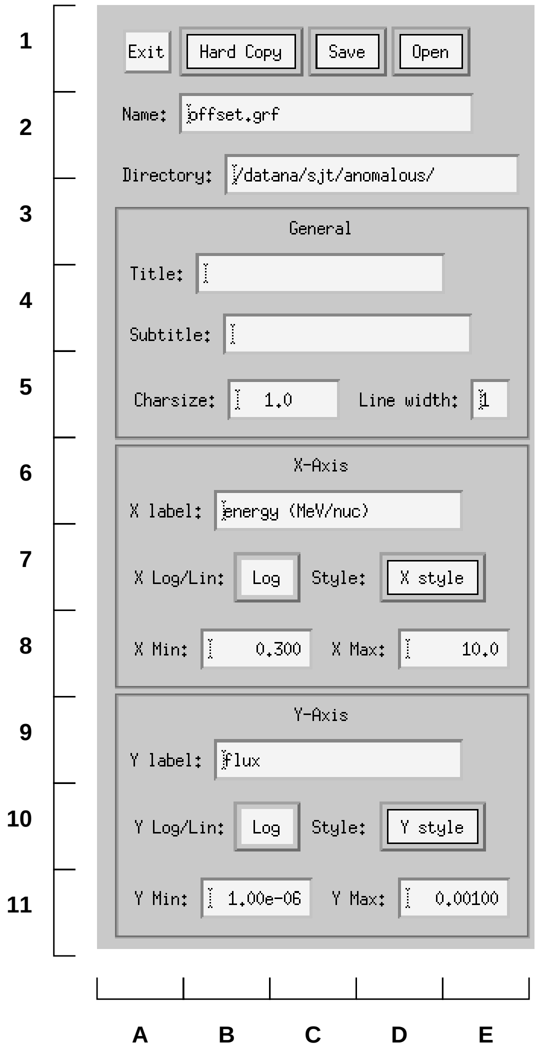

FIGURE 2: *The panel to the left of the* GRAFFER *plot window.*

space. If this is enabled, then when the cursor is moved across the drawing area, a pair of cross hairs follows it and the current location is indicated in the windows below the control button. When this is disabled (e.g. on a slow machine) then this does not occur. In graphical mode, then cross hairs are continuous, in text mode they are dashed.

4.2 Axis settings

The settings for the two axes are identical in terms of the available options and the way of settings them, therefore I shall consider only a generalised axis setting. The available settings are:

label: (FIG. 2(B6,B9)) Put a title on the axis.

Log/linear: (FIG. 2(B7,B10)) Whether the Axis is to be logarithmic or linear, the undisturbed button of the pull down menu displays the current state.

style: (FIG. 2(D7,D10)) This pull down menu covers the various options contained in the `[XY]STYLE` keywords[7] to `PLOT`, plus the presence or absence of minor ticks. Each item below has an On/off submenu to toggle its state.

Exact Range: When on set the axis range to exactly the value requested, when off (default) round it up to the next "nice" value.

Extended Range: When on then the axis range is extended by about 5% at each end over the value it would otherwise have (this is done after the exact/rounded decision has been taken). The default is off.

Draw Axes: When on (the default) the Axes are drawn, when off they are omitted.

Draw box axes: When on (the default) axes are drawn all around the plot, when off only the left and lower axes are drawn (subject to Draw axes being on of course).

Minor ticks: When on (the default) then minor ticks are drawn between the major tick marks (the exact number is determined by IDL), if it is turned off then only the major tick marks are drawn.

Range: There are two windows one for the minimum (FIG. 2(B8,B11)) and one for the maximum (FIG. 2(D8, D11)) of the axis. These accept floating point values, if they are unsuitable[8] then the plot update is not performed.

5 Text

In addition to the standard plot labels, it is also possible to add text at any arbitrary location on the plot using `GRAFFER`. To add or edit text items it is necessary to switch into *text mode* this is done by the *draw/text mode* pull down menu towards the right of the lower panel (FIG. 1(H1)). When you are in text mode, if cursor tracing is enabled, the solid crosshairs are replaced by dashed ones to serve as a reminder the current mode.

To add a line of text, click with the *LEFT* mouse button where you wish to place the text, then the text entry window will appear to allow you to enter the text string and set up its properties. To edit and/or move an existing line of text, place the cursor near to the text anchor point[9] and click the *CENTRE* mouse button at this point the text entry window will pop up to allow you to edit the text string and alter its properties. To delete a text item, place the cursor near its anchor point and click the *RIGHT* mouse button, for safety reasons the cursor must be within 5 pixels of the anchor point.

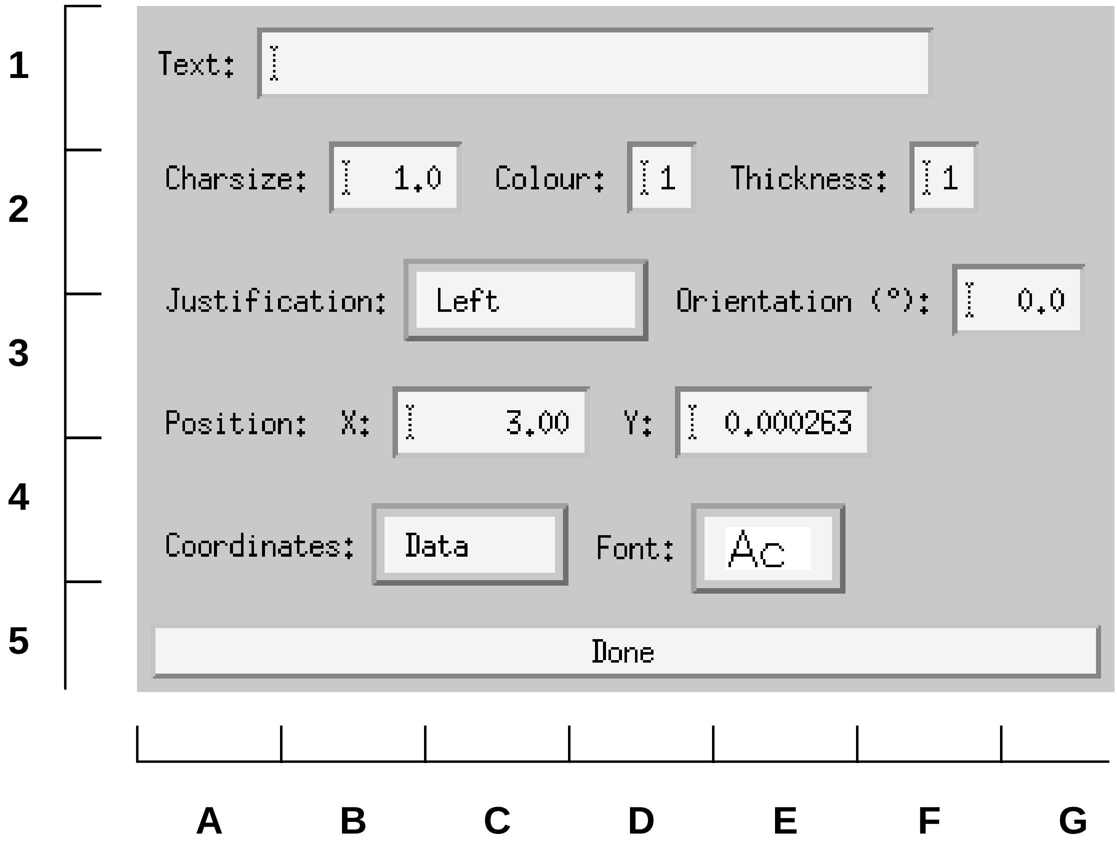

FIGURE 3: *The text entry window of* GRAFFER.

5.1 The text entry window

The text entry window is a pop-up window which appears when a text string is to be entered or edited. There are a considerable number of user-settable fields in this menu:

The text string itself: [10] (FIG. 3(A1)) This is a text entry widget into which you can type the text string to be displayed. Any of the IDL graphics controls (!<char> commands) may be used as these text strings are always displayed in vector fonts.

Character Size: (FIG. 3(B2)) Enter a floating-point value to give the character size in terms of the default value. When hardcopies are made, the size is adjusted to give the same number of characters across the page as were on the screen.

---

[7] Note that as an axis range is always given, there is no need for a Y-axis setting for suppressing the range going to zero for positive-definite y data.

[8] e.g. equal limits or a negative or zero limit for a logarithmic axis

[9] The text anchor points are denoted by small arrows, these arrows will not be printed when you make a hardcopy

[10] If no text string is given it will be displayed as <NULL>, this will not be printed on a hardcopy, nor is it displayed while editing the text. Also, text items after the current one may not appear while editing is in progress.

Colour: (FIG. 3(D2)) The colour of the text, the same colour indices apply as for plots (Table 1).

Thickness: (FIG. 3(F2)) Enter an integer value to specify the line thickness to be used for the character drawing. This should be used with caution, but the results in hardcopy are usually better than the X-windows display suggests.

Justification (FIG. 3(C3)) A pull down which allows you to set Left, Centre, Right or otherwise-justified text. For non-standard justifications a pop-up with a slider is used to set the justification in the range 0.0 (Left justified) to 1.0 (Right justified).

Orientation: (FIG. 3(F3)) Set the orientation of the text. This is measured in degrees anti-clockwise from the normal position of parallel to the X-axis and going left to right.

Position: Set or adjust the position of the anchor point, both X (FIG. 3(B3)) and Y (FIG. 3(D3)) are floating-point numbers and are given in the currently selected coordinate system.

Coordinate system: (FIG. 3(B4)) A pull down to select Data or Normalized coordinates as the system in which the text is anchored. The default is data, but if you wish the text to remain in the same place on the page when you change the axis range, then use normalized.

Font: (FIG. 3(E4)) A pull down to select the font. All the vector fonts are available, the letters "Ac" are given on the buttons to facilitate distinction of the greek and cyrillic fonts from their companion roman fonts.

When you are happy with the text string, then click on the *Done* button (FIG. 3(A5)).

6 Printing, Saving etc.

The final aspect of the operation of GRAFFER to consider is how to get out of it, save files, print them and otherwise make them useful. These operations are controlled by the pull down menu at the top left of the main GRAFFER window.

Exit: (FIG. 2(A1)) Exit from GRAFFER and return to the IDL> prompt. If the current file has been changed, then a pop up menu will appear asking you whether you want to save the file, cancel the exit or proceed.

Hard Copy: (FIG. 2(B1)) Generate a PostScript file from the GRAFFER file. There are two options to the pull down:

Quick Generate the PostScript file with the current set of options.

Set Up Produce a pop up menu to configure the PostScript options. This allows you to select (monochrome or colour), (normal or encapsulated), (portrait or landscape), the X and Y sizes of the page in mm. Additionally if "normal" Postscript is generated, a spool command may be set and an optional timestamp applied to the plot. Note that landscape mode and encapsulated PostScript may not produce what you want unless you really want the file to be included on its side into the receiving document—use portrait mode with the X size larger than the Y size. The filename will be the stem of the `GRAFFER` file with either `.ps` or `.eps` as the extension as appropriate.

Save: (FIG. 2(C1)) Save the current file[11]. This is a pull down menu with three options:

Save to Current Save the file as a normal `GRAFFER` file with its current name and location.

Save as ... Pops up a menu to allow you to change the filename and/or directory before saving.

Dump Screen > A further pull down to dump the screen to one of several image file formats:

- GIF - graphical interchange format.
- TIFF - Tagged image file format.
- NRIF - NCAR raster image format

JPEG format is not available as it is unsuitable for line graphics.

Open: (FIG. 2(D1)) Open a new `GRAFFER` file. There are two pull down items to this:

Restore ... Generate a `PICKFILE` menu to select an existing file.

New ... Generate a pop up to set the name of a *NEW* `GRAFFER` file[12].

In either case if you try to open a new file when the current file is changed but not saved the same three option menu will appear as on the Exit button.

A GRAFFER file format

A `GRAFFER` file is a fairly simple ASCII file which if you really need to mess with it isn't too difficult to follow. The following example produces the graph in FIG. 4.

General `GRAFFER` header, gives `GRAFFER` version number, filename and date.

```
Graffer V 1.03: /datan8/sjt/graffer/demo.grf : @ Thu Oct  5 17:55:41 1995
```

Title, subtitle, character size and line thickness for axes

```
Simple set of plots
Graffer V1.03 Demo
      1.70000       2
```

X-axis, range (min and max), linear, default IDL style settings, title.

```
     -1.00000      1.00000
       0       0
Fractional Displacement
```

[11] Every 20 operations or 5 minutes (whichever is the shorter) the file is auto-saved to a file whose name is the current filename surrounded by hashes (#)

[12] If the file does exist it will be overwritten on the first save.

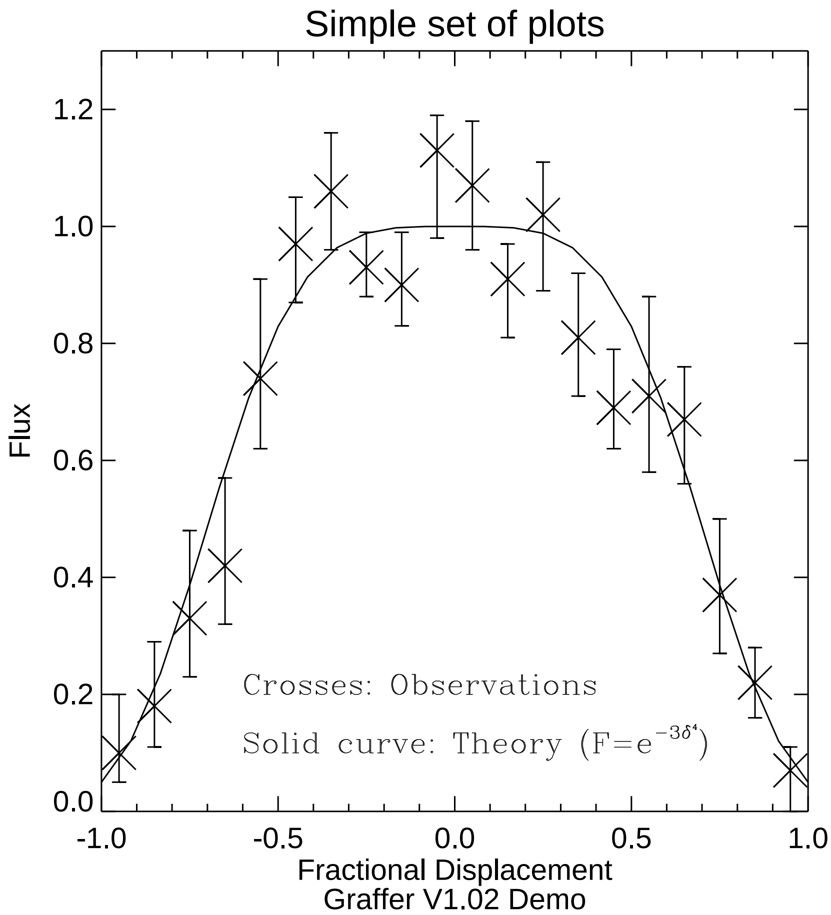

FIGURE 4: *A simple* GRAFFER *figure, described by the example file.*

Y Axis, same layout as X but now style=33 (exact axis range and no minor ticks)

```
    0.0100000       1.00000
       0        33
Flux
```

Total number of defined data sets and currently selected set index (N.B. this has a zero origin while the indices given in the chooser have an origin of 1).

```
       2        1
```

First data set: line 1: Symbol, Symbol size (ignored for symbol=0), linestyle, colour, line thickness, x-axis sorted?, number of points.
line 2: Label
line 3: XY data set or function (-1 means function of X, see Table 2 for the full list) line 4: X range over which to define function (2 equal values means whole axis)
line 5: The actual function definition.

```
       0      0.00000       0       1       2   0      25
Theory
       -1
      0.00000      0.00000
exp(-(x^4*3))
```

Second data set: line 1: Symbol, Symbol size, linestyle, colour, line thickness, x-axis sorted?, number of points.
line 2: Label
line 3: XY data set or function (2 means XY data with asymmetric errors)
line 4 *et sqq.*: the data as x,y, err low, err high sets

```
       7      2.00000       0       1       2   0      20
Measurements
       2
    -0.950000     0.100000    0.0500000     0.100000
    -0.850000     0.180000    0.0700000     0.110000
    -0.750000     0.330000     0.100000     0.150000
    -0.650000     0.420000     0.100000     0.150000
    -0.550000     0.740000     0.120000     0.170000
    -0.450000     0.970000     0.100000    0.0800000
    -0.350000      1.06000     0.100000     0.100000
    -0.250000     0.930000    0.0500000    0.0600000
    -0.150000     0.900000    0.0700000    0.0900000
   -0.0500000      1.13000     0.150000    0.0600000
    0.0500000      1.07000     0.110000     0.110000
     0.150000     0.910000     0.100000    0.0600000
     0.250000      1.02000     0.130000    0.0900000
     0.350000     0.810000     0.100000     0.110000
     0.450000     0.690000    0.0700000     0.100000
     0.550000     0.710000     0.130000     0.170000
     0.650000     0.670000     0.110000    0.0900000
     0.750000     0.370000     0.100000     0.130000
     0.850000     0.220000    0.0600000    0.0600000
     0.950000    0.0700000    0.0700000    0.0400000
```

Number of text strings.

```
       2
```

First text item: Lines 1 & 2: colour, size, orientation, alignment (0.0 left justified, 0.5 centred, 1.0 right justified), primary font, line thickness, x position, y position, coordinate system (0 data, 1 normalized).
Line 3: The text string.

```
       1      2.00000      0.00000      0.00000       6       1    -0.600000
     0.100000   0
Solid curve: Theory (F=e!u-3!7d!e4!n)
```

The same for the second text item.

```
       1      2.00000       0.00000       0.00000        6        1    -0.600000
     0.200000   0
Crosses: Observations
```

Hardcopy options: Line 1: Colour (1)/Monochrome(0), Encapsulated(1)/Normal(0), portrait(1)/Landscape(0), Timestamp On(1)/Off(0), X and Y sizes of page in cm.
Line 2: The printing command and any options that precede the filename.
Line 3: Any print options that follow the filename (none here)

```
   0   1   1   0      12.0000      12.0000
lp
```

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