



Users Manual

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1

Introduction

1.1 Welcome

 **Plot** is a tool to generate Cartesian X/Y-plots from scientific data. The design and user interface of the program enables you to enter and calculate tabular data. You can view the changing graphs, including linear and non linear regression, interpolation, differentiation and integration, during entering the data. A powerful reporting module generates ready to publish documents.

I have tried to keep the program as simple and intuitive as possible, to enable you to create plots fast and easily. Thus it can be handled also by persons who are not software- or mathematics-experts. The options can be changed interactively. The result on the screen is the same as on the report printout (what you see is what you get).

Although the program looks simple, the graph can be altered in any item you can imagine. All distances in axis, scaling, numberings, captions colors, line- and point styles and colors can be altered. Thus a plot can be generated fitting the requirements of any journal you want to publish in and of course your personal taste.

Nobody is perfect, not me not you and especially no software. If you notice any errors within this manual or the program, or if you have any wishes for future developments, please do not hesitate to contact me via e-mail (support@rt-science.com).

The graph engine developed for this program is available as components for Borland® Delphi and C++ Builder, please see <http://www.rt-science.de> for details.

I wish you a successful work using  **Plot**.

November 2004

Horst Reichert

1.2 License

Trial version

The trial version may only be used to evaluate  **Plot**. The evaluation can be done during a period of 30 days from the first start of the program. It may not be used for any commercial work during this period.

Registered version

The registered version may be used without any limitations in time. The software supplied may be used by one person on one computer. If for any reason the program must be installed on a different new computer, the software must be de installed on the old computer. The user is not allowed in any case to give other parties any information about the registration key sent to him.

Liability Limitation

This documentation and the  **Plot** software are provided “As Is” without warranty of any kind, expressed or implied, including but not limited to the implied warranties of merchantability and/or suitability for a particular purpose. The user assumes the entire risk of any damage caused by this software.

In no event shall Horst Reichert be liable for damage of any kind, loss of data, loss of profits, interruption of business or other pecuniary losses arising directly or indirectly from the use of the program. Any liability of the seller will be exclusively limited to replacement of the product.

Good data processing procedure dictates that all programs be thoroughly tested with non critical data before they can be relied upon.

1.3 About this Manual

For better understanding this manual uses special formats to emphasize special meanings.

Hints, which give a description of things not directly needed for a special topic, but which will keep you work easier or more efficient; will be inside a frame with gray background.

Expert options, which should be used only by experienced users and with great care, are put inside a red frame.

Descriptions for keystrokes will use the labels of standard American keyboards. Depending on the manufacturer and the language of your computer those labels will differ. Combined keystrokes as e.g. pressing the Ctrl-key and the C-key simultaneously are expressed as `Ctrl C`.

Within the description of the program some options are accessible via the Windows menu system. Menu items will be described as **Main menu item – Sub menu item**. If any special item included in a window is named, this is marked as: **Option**. The window itself will be described as *Window Name*.

The program uses standard Windows™ menus, toolbars, controls and dialogs. Thus this manual will not explain e.g. how to select a file or color. If you have problems using Windows™ please refer to the Microsoft™ manuals or the Windows™ help.

Please note that most of these options are also available within so called object menus. Thus right clicking at an object will show those menu options relevant for this object. Some of these options might not be explained within this manual.

The pictures embedded into this text were captured on a Windows™ XP computer. Thus the lookout of the controls, especially buttons will be different from the more “classical” systems.

1.4 Installation

 **Plot** is developed for 32 bit Windows™ (95/98/2000/ME/NT4.0/XP) operating systems. For a good performance, at least 64MB of RAM-memory are recommended. Please be also sure to have enough disk-space left for temporary files etc. We recommend having at least 20MB hard disk space free.

The layout of the program was optimized for a color display of 1024x768 pixels.

Please be sure that if you are running a “professional” Windows™ you must have enough user rights to install programs. If not, please contact your system administrator.

The installation files are placed on the CD-ROM attached to the last page of this manual. Please insert the CD into the drive on your PC. The setup program will start automatically. If you have disabled the auto start option of your CD you have to execute the “Setup.exe” via the normal Windows™ procedure.

The setup program will guide you through the whole installation process. We recommend to you just to select the “Next>” -option if requested. The setup program creates all necessary directories and copies the files to the correct places. The program will also modify the Windows™ Registry to enable the automatic loading of  **Plot** if a “*.plt” -file is double clicked in a drive or explorer window.

1.5 Registration

 **Plot** is distributed as shareware. This means that you are allowed to copy the program files and give to anyone you know. After installation you will be able to evaluate the program and all of its features for 30 days. After this period the program will not work any more without registration.

You can order a user license directly from the author by mail (For the license conditions see chapter 1.2 on page 2):

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Fax: +49 + (0)6198 501537

Or from the web: <http://www.rt-science.de>.

Afterwards you will receive the registration data via e-mail. The registration data consist out of 3 items:

1. Serial number
2. User name
3. Registration key

You can register the program selecting the  button within the nag window at start of the program, or any time during evaluation using the  **Help – Registration** menu option.



Within the registration window you can enter the registration information. After accepting the registration data, the program will now run without any nag window at the start and continue work after the 30 days trial period.

It is sometimes very tedious to type in all the chars and numbers of the registration key, thus we recommend marking the relevant text within the mail viewer and copying the chars to the clipboard using **Ctrl C** and paste into the edit field using with **Ctrl V**.

2 General Use

2.1 Program start

The program can be executed using the start menu of Windows™ selecting the  icon in the programs folder.

If you prefer a more document oriented working style, you can double click any  **Plot** file (Extension .plt) in any drive or explorer window. Afterwards  **Plot** will load the selected file and display the calculations using the last selections.

2.2 Program Modules

For a better understanding this chapter will introduce the main modules of  **Plot**. The following chapters will give more detailed descriptions of all the functions and options available in each part.

The center of all activities is the *Data Table*. This window holds a table of all the numerical data. This window is also the central to load and save  **Plot**-data.

The columns of this table can be used to enter numbers or to show calculated values within so called “live columns”. These columns can be the base of other calculated columns and can be the source of the data used for a line in a graph. This is done by assigning the columns to X- or Y-Axis values of data series within a graph. The columns can also be assigned as the values used for a statistical weight within regression line calculations and dimensions of error bars around the data points.

The assignments used to show the data within the graphs are visible in the top lines, and can be altered in the *Graph Window* (see chapter 4.1.1 on page 20).

A detailed description of all the possibilities of the *Data Table* is available in chapter 3 on page 9.

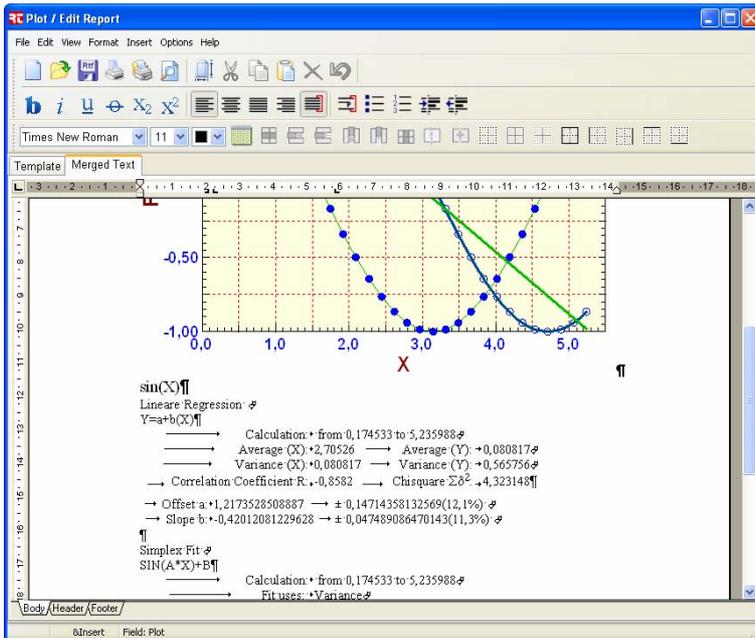
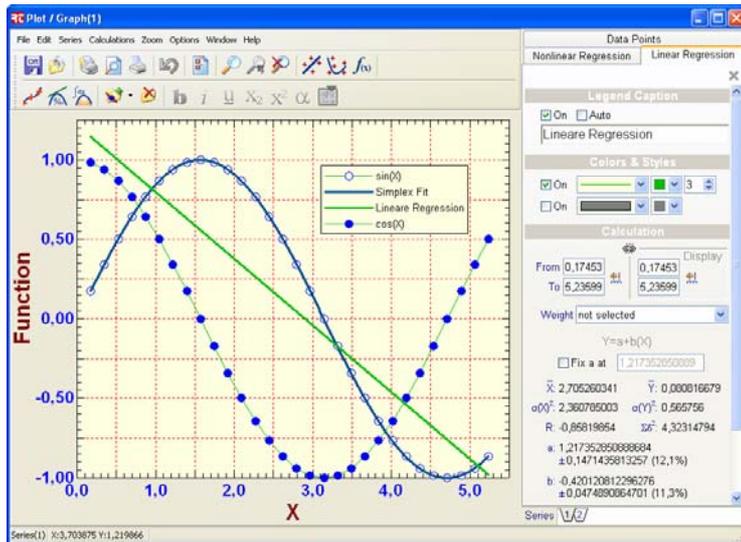


Graph(1)	X(1,2)	Y(1)	Y(2)
Caption	X	Function	Function
Formula		sin(a)	cos(a)
#	A	B	C
1	0,1745329251	0,1736481776	0,9848077530
2	0,3490658503	0,3420201433	0,9396926207
3	0,5235987755	0,5000000000	0,8660254037
4	0,6981317007	0,6427876096	0,7660444431
5	0,8726646259	0,7660444431	0,6427876096
6	1,0471975511	0,8660254037	0,4999999999
7	1,2217304763	0,9396926207	0,3420201433
8	1,3962634015	0,9848077530	0,1736481776
9	1,5707963267		-0,4914833611
10	1,7453292519	0,9848077530	-0,1736481776
11	1,9198621771	0,9396926207	-0,3420201433
12	2,0943951023	0,8660254037	-0,5000000000
13	2,2689280275	0,7660444431	-0,6427876096
14	2,4434609527	0,6427876096	-0,7660444431

The numerical data are represented within at least one *Graph Window*. This window shows the graphs of all assigned column data. The options of the lines, symbols and calculation parameters can be altered directly at the right. All the dimensions, colors and styles of the graph, the axis and legends can be altered using the **Options – Graph, Axis and Legend Parameters** function (see chapter 4.2 on page 22).

The *Graph Window* also contains the functions for adding calculated lines as linear, non linear regression, interpolation, smoothing, differentiation and integration.

Within the menus of this window various other functions are accessible as: outfit file functions, graph and report export, report editing, preview and printing of reports. A detailed description of the options follows in chapter 4 on page 19.



The reports can contain any calculation result related to the added function lines and the graph. It is processed by merging a template document with the actual data. These documents are freely editable with options similar to those of your favorite word processor. You can learn how to modify reports in chapter 5 on page 39.

2.3 User Interface

2.3.1 Context Sensitive Help

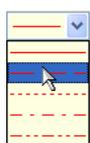
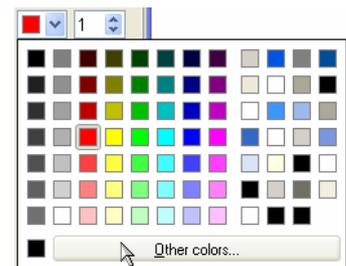
Within the installation procedure, the  **Plot** help system was added. As usual under Windows™, pressing the **F1** function key opens the help window containing the item most relevant to the current position in the program. In some sub-menus this can also be executed clicking the  button. The contents page of the help file is always reachable with the **Help – Contents** menu function. With most buttons and other controls which do not have any text with it, so call fly over hints are implemented. This means if you point the mouse to a control, and wait for some seconds, a small text will pop up to explain the control. After some time the text will disappear again.

2.3.2 Changing Colors, Lines and Point Symbols



Every background, line, point symbol etc. within the graphs of  **Plot** can be changed. To assist you in this task, some special drop down selection controls were developed.

The colors of the background, data area, lines and point symbols can be set with the color picker control. A color palette shows the currently selected color as a depressed button. The left major part of the palette shows different shades of the major colors. At the right side some colors from the Windows™ system setting are listed. If you point the mouse for some seconds to the palette item, a hint will pop up showing a description as e.g. “Button Face” or “Window”. It might be necessary to select a color not available within the pickup palette. Thus at the bottom line the standard Windows™ color selection dialogue can be opened using the  button. With the standard dialog you can set up any RGB color value you like. If you re open the color picker again the new “other” color will be shown in the left bottom corner.

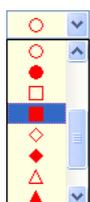


The line style combo box shows a list of all line styles available as solid, dashed, dotted etc. ready for selection.

Please note that if you want to show non solid lines in the graph, the width or thickness of the line must be set to a value of 1 or 0! The Windows™ graphic drivers are not capable to display non solid lines with width higher than 1.

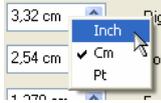


The area filling style combo box shows a list of all filling types available from solid fill to hatch fill.



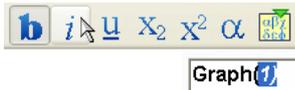
The point style combo box shows a list of all point styles available. Most symbols as circles, triangles, squares, stars etc. are available as solid filled and outline versions.

2.3.3 Unit edit fields



In some dialogues, especially in the *Report Editor* window the numbers can have different units. The unit of each edit field can be altered by right clicking at the control and choosing the appropriate unit within the pop up menu.

2.3.4 Special Caption Edit



Graph

As scientists need more options formatting a graph title, captions to columns, axis and graph series legends. Within the edit fields of such items extended format options are available, similar as in your favorite word processor. Using the cursor keys or the mouse the text can be marked and special attributes as bold **b**, italic *i*, underline u, strike out ~~⊖~~, subscript _{x₂}, superscript ^{x²} and symbol font α can be set. To assist in selecting non keyboard characters the characters table  can be popped up.

Inside this table you can select any character by the mouse. Double clicking at it will insert this char at the current cursor position.

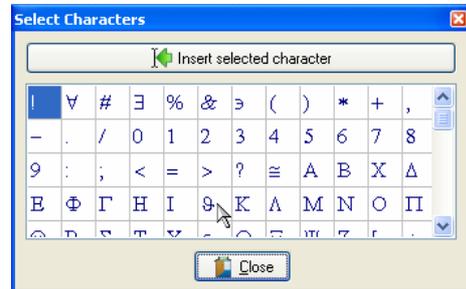
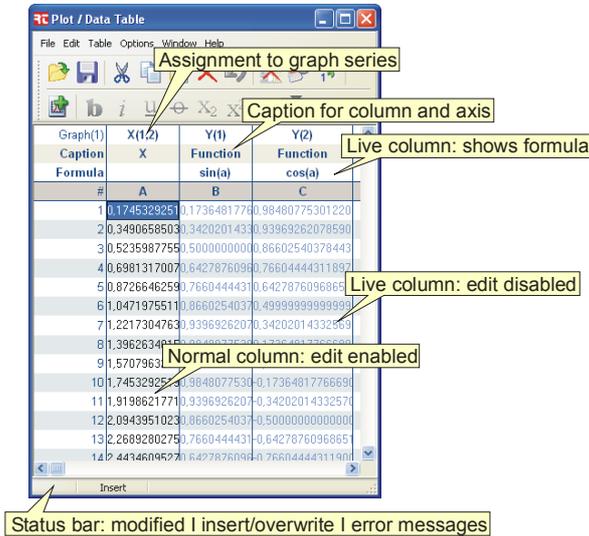


Table 1: Keys active in the caption edit

Key	Function
	Move caret one position left
	Move caret one position right
	Move caret to begin of word
	Move caret to begin of next word
	Move caret to begin of input
	Move caret to end of input
	Extend selection one position left
	Extend selection one position right
	Extend selection to begin of word
	Extend selection to begin of next word
	Extend selection to begin of input
	Extend selection to end of input
(Backspace)	Delete character left to caret / delete selection
	Delete character at caret right / delete selection
	Switch insert/overwrite mode; caret changes accordingly
	Erase from caret to the end
	Select all
	Undo changes
	Copy selection to clipboard
	Cut selection to clipboard
	Paste text from clipboard
	Superscript mode on/off
	Subscript mode on/off
	Bold mode on/off
	Italic mode on/off
	Underline mode on/off
	Strikeout mode on/off
	Switch on/off symbol font

3 Data Table



The *Data Table* window is the heart of **Plot**. It holds all numerical data. The data are ordered in columns A...Z (see also Appendix A on page 47). Each column can contain a virtually unlimited number of row values #. The “normal” columns will show black numbers, indicating, that editing of the values is enabled. Automatically recalculated “live” columns will show the calculation formula in the header line. The calculated values are displayed with a gray text color, indicating that editing is not possible inside these cells. Within the “Caption” row of each column the header caption can be entered using special formatting options (see chapter 2.3.4 on page 8). If the column is assigned as last series

within a graph, this caption can be automatically used as axis caption for the relevant axis (see chapter 4.2.2 on page 23). On top of the table the assignments of each column to graph series axis, weights and error bar distances are displayed.

3.1 Entering Data

Within the tables data area one cell is highlighted normally by a blue background. This is called the active cell. You can move this cell to any position by the cursor keys or just click it with the mouse. Pressing the **[F2]** key or clicking again, will change to the cell editing mode:

If the cell contains any data the values are marked completely. If you now would enter any number the content will be replaced by the new entry. If you want to alter a part of the number just use the cursor keys or the mouse to position the caret at the desired position.

If a value was entered all the columns which contain “live” data will be recalculated automatically, thus values related to the changed cell are updated immediately. If there is a graph series assigned to any value which was changed, the resulting graph also updates immediately, including all related calculated lines.

Normally you would prefer to enter numbers or captions for rubrics to the columns (see chapter 4.2.2 on page 24). In some cases data are acquired on a date and Time base. **Plot** enables you to do this task using the **Table – Date-Time Column** option. Switching on this column representation will show the values as date and time according to your Windows™ system settings of the short date format and time format **29/1/4/1900 1:28:29 AM**. The input must not be complete. The missing parts will be completed with 0, 1 or 1899.

Internally the data are stored as normal floating point values. The conversion is made according to ISO 8601 as days in relation to 0= "12/30/1899 12:00 am". The results of calculations have to be interpreted as "per day". The fractional part corresponds to the time as part of the whole day. E.g. 2.75 is 1/1/1900 6:00 pm.

Table 2: Special Mouse features

Cursor	Description
	Move mouse to column divider line. Drag line until column width is correct.
	Move mouse to column header. Click to mark the whole column. If you press Ctrl when clicking, the existing selection will be extended. Multiple discontinuous selections are possible.
	Move mouse to row number. Click to mark the whole row. If you press Ctrl when clicking, the existing selection will be extended. Multiple discontinuous selections are possible.
	Move mouse to row number and row label header row. Click to mark the whole table.
	Move mouse to any cell. Drag mouse to any other cell. The dragged range will be selected. If you press Ctrl when clicking and dragging, the existing selection will be extended. Multiple discontinuous selections are possible.

Table 3: Keys active in the edit mode

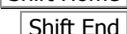
Key	Function
	Move caret one position left
	Move caret one position right
	Move caret to begin of word
	Move caret to begin of next word
	Move caret to begin of input
	Move caret to end of input
	Extend selection one position left
	Extend selection one position right
	Extend selection to begin of word
	Extend selection to begin of next word
	Extend selection to begin of input
	Extend selection to end of input
(Backspace) 	Delete character left to caret / delete selection
	Delete character at caret right / delete selection
	Select all
 	Undo changes
	Copy selection to clipboard
	Cut selection to clipboard
	Paste text from clipboard

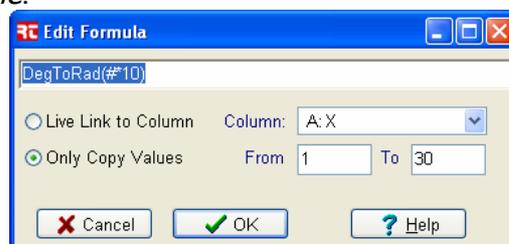
Table 4: Keys active in the data area

Key	Function
←	Move active cell one position left
→	Move active cell position right
Ctrl ←	Move active cell one page left
Ctrl →	Move active cell one page right
Ctrl ↑	Move active cell to first row and first column
Ctrl ↓	Move active cell to last row and last column
Home	Move active cell to column A
End	Move active cell to last column
Ctrl PgUp	Move active cell to first row
Ctrl PgDn	Move active cell to last row containing data
Shift ←	Extend/reduce selected range one cell left
Shift →	Extend/reduce selected range one cell right
Shift ↑	Extend/reduce selected range one cell up
Shift ↓	Extend/reduce selected range one cell down
Shift Home	Extend selected range to column A
Shift End	Extend selected range to last column
Ctrl Shift Home	Extend selected range to first row
Ctrl Shift End	Extend selected range to last row
Ins	Insert cell
Ctrl Ins	Insert row
Shift Ins	Insert column
Del	Delete active cell / selected range
Shift Del	Delete column
Alt C	Mark column
Alt R	Mark row
Alt F	Edit formula

3.1.1 Calculating columns

In most cases a scientist need to derive data from so called raw data. This means the raw data need recalculation by some formula correcting offsets multiplying factors etc...  **Plot** uses a formula interpreter to achieve these tasks. Unlike spreadsheets as e.g. Excel™ which does calculation on cell formula base, this program uses a column oriented approach to do this task. Each part of a column can be calculated by formula using the **Table – Edit Formula** option or just clicking the formula row of the *Data Table*.

A small window will pop up, giving you the ability to calculate the data values with any formula. The top field displays the calculation formula. With the **Only Copy Values** radio button you can select that the values are directly copied to the table. The range of calculation can be selected by the Column pull down list and the **From** and **To** edit fields for the rows. If a column range was marked before opening the *Edit Formula* window, the fields will be preset matching the range. Clicking  will



calculate the range with the formula. All live columns which are related to these values are recalculated and the graphs are updated accordingly.

The formula can contain several operators compatible to BASIC or PASCAL syntax with the addition of the power operator, \wedge . Case is not significant when matching function names or the 'E' character used in scientific notation. Spaces and tabs are ignored.

The grammar follows the normal rules of arithmetic precedence, with \wedge highest, * and / in the middle, and + and - lowest. Thus $1+2*3^4$ means $1+(2*(3^4))$. Note that the power operator X^y is right-associative. Thus $2^0.5^2$ means $2^{(0.5^2)}$. All other arithmetic operators are left associative: $1-2-3$ is equivalent to $(1-2)-3$. Parentheses can be used to force non-default grouping. Trigonometric functions as $\sin()$, $\cos()$ etc. have radiant as argument, the reciprocal angle functions have radiant as result.

Table 5: Syntax for Calculation of Columns

Variables

A...Z	Value of the relevant column with the current row index (same as: A(#)...Z(#))
A(...Z)	The value of a cell in the relevant column, the row index specified as argument
#, Row	The current row index, indicated in the first column of the data table

Operators

+	Plus
-	Minus
*	Times
/	Divided by
\wedge	To the power of

Functions

abs()	Absolute value
arccos()	Inverse cosine
arccosh()	Inverse hyperbolic cosine
arcsin()	Inverse sine
arcsinh()	Inverse hyperbolic sine
arctan()	Arctangent
arctanh()	Inverse hyperbolic tangent
ceil()	Lowest integer greater than or equal to argument. The absolute value of argument must be less than 2147483647. For example: Ceil(-2.8) = -2; Ceil(2.8) = 3; Ceil(-1.0) = -1
cos()	Cosine
cosh()	Hyperbolic cosine
cotan()	Cotangent
DegToRad()	Degrees to radian
exp()	Exponential (power to base e)
floor()	Highest integer less than or equal to argument. The absolute value of argument must be less than 2147483647. For example: Floor(-2.8) = -3; Floor(2.8) = 2; Floor(-1.0) = -1
frac()	Fractional part
int()	Integer part
ln()	Natural logarithm
lg(), log10()	Logarithm with base 10
log2()	Logarithm with base 2
RadToDeg()	Radian to degrees
round()	Argument rounded to the nearest whole number. If argument is exactly halfway between two whole numbers, the result is always the even number. This method of rounding is often called "Banker's Rounding".
random	Random number within the range $0 \leq 1$
rnd()	Random number with the range 0 to Argument
sin()	Sine
sinh()	Hyperbolic sine
sqr()	Square
sqrt()	Square root
tan()	Tangent
tanh()	Hyperbolic tangent
trunc()	Argument rounded toward zero

Constants

pi	3.14159...	π
cR	8.3143	Ideal Gas Constant [J/(K*mol)]
ck	1.38062e-23	Boltzmann Constant [J/K]
cVmol	22.4136	Molar Volume of ideal Gas [l/mol]
can	6.02217e23	Avogadro's Number [1/mol]

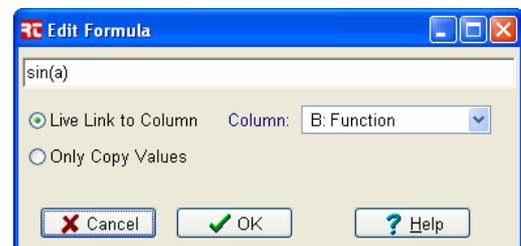
cG	6.673e-11	Gravitation Constant [N*m ² /kg ²]
cc	2,997925	Speed of Light [m/s]
ce0	8.8542e-12	Electrical Field Constant [A*s/(V*m)]
cmu0	1.2566e-6	Electrical Induction Constant [V*s/(A*m)]
ce	1.602192e-19	Elemental Charge [C]
cF	9.64867e4	Faraday Constant [C/mol]
ch	6.6262e-34	Plank Constant [J*s]
chq	1,0546e-34	Plank Constant /(2*Pi)

The list of physical constants can be altered and extended to your needs (see Appendix A on page 47)

Examples:

- Sin(Pi*#/10) Multiply row number by π divide by 10 and take the sine of the result.
- Lg(abs(a)) Derive the logarithm to base 10 of the positive magnitude of column A.

If you want to keep the formula values always up to date when any source value changes, the radio button **Live Link to Column** can be selected. If the formula is accepted by clicking , all the values up to the maximum row value in any column are recalculated. The formula row of the column header shows the active “live” formula. The column values are displayed with gray text color indicating that the cells cannot be edited.



3.1.2 New Graph-Window

You can link the columns of the *Data Table* to as many graphs you like. The X- and Y-Values of the data series are assigned within the *Graph Window* (see chapter 4.1.1 on page 20). You can create a new *Graph Window* using the  **Table – Create Graph** menu option.

3.2 Menu Functions

As some of the functionality of the *Data Table* was not described above, the following chapters will list the missing options ordered as they appear in the main menu.

3.2.1 File Functions

The most important file functions are  **File – Save**  **File – Save as**, and  **File – Open**. With a standard Windows™ file selection dialog, you can select a filename to store or load all data, assignments and graphs. The last loaded/saved files will be displayed as a history list at the bottom of the **File** sub menu. You can easily load the last files just clicking to the name in the list. The files will all have the extension “.plt”, indicating the files were created/can be opened with  **Plot**.

The option  **File – Clear All** will delete all table data, all assignments and all graph calculations, thus the program looks as it was freshly started.

The **File – Import Table** function can be used to load data processed by other programs. With a standard window file selection dialog, you can select a filename to import the data.

The file must be a pure ASCII-text file. You can use either Tab-Characters (#9) or the Windows™ list separator or Commas to separate the column items. Rows are separated by Carriage Return (#13). The first row is used as captions for the column headers if containing no numbers. The following rows are treated as numbers and inserted starting from row number 1 until the end of the file.

Please note that you cannot use the Comma as list separator and decimal separator simultaneously. Thus if you use e.g. German language settings you must use the Tab or any other separator usually “;” in between the values.

In most cases it is more convenient to use the clipboard functions to do this task (see chapter 3.2.2 on page 15). Just mark a range in the exporting program and copy with . Then go to any cell inside the *Data Table* of  **Plot** and paste with . The values will be inserted starting from the active cell.

The **File – Export Table** is the reverse of the above. It can be used to export the table data to other programs. With a standard Windows™ file selection dialog, you can select a filename to export the data. Within the dialog you can select whether you want to generate a file with columns separated by Tab-Characters (#9), the Windows™ list separator or commas. The rows will be separated by Carriage Return (#13). The first row will contain the captions of all columns containing data. The following rows will contain the numbers until the last row containing data.

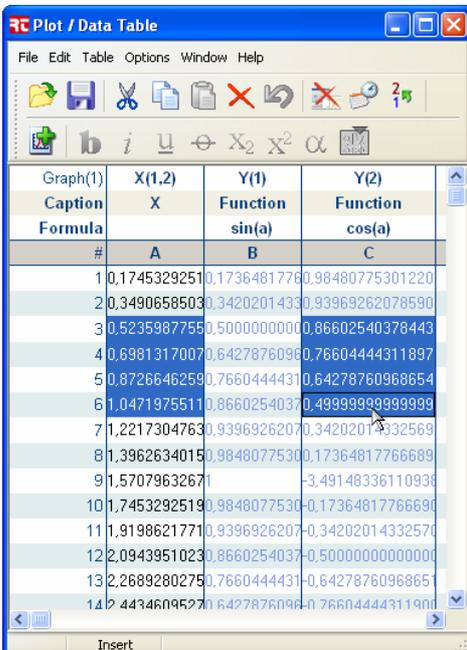
In most cases it is more convenient to use the clipboard functions to do this task (see chapter 3.2.2 on page 15). Just mark a range in the *Data Table* and copy with . Then go to the importing program and paste with .

As in all programs confirming the Windows™ standard, **Plot** is closed choosing the **File – Exit Program** option or by clicking at the close button in the right top corner of the *Data Table*, which is the main window of the program.

3.2.2 Clipboard Functions

As most other Windows™ programs **Plot** also supports data transfer from program to program and input field to input field via the clipboard functions. This means if you have marked any text or table range, this selection can be copied or cut into the clipboard and pasted to any program supporting clipboard functions. The functions are accessible via the **Edit** menu – **Cut – Copy – Paste** with the toolbar buttons    and the keyboard **Ctrl C**, **Ctrl X** and **Ctrl V**.

Please refer to Table 2 on page 10 and Table 4 on page 11 to learn how to mark ranges with the *Data Table*.



Graph(1)	X(1,2)	Y(1)	Y(2)
Caption	X	Function	Function
Formula		sin(a)	cos(a)
#	A	B	C
1	0,1745329251	0,1736481776	0,98480775301220
2	0,3490658503	0,3420201433	0,93969262078590
3	0,5235987755	0,5000000000	0,86602540378443
4	0,6981317007	0,6427876096	0,76604444311897
5	0,8726646259	0,7660444431	0,64278760968654
6	1,0471975511	0,8660254037	0,49999999999999
7	1,2217304763	0,9396926207	0,34202014332569
8	1,3962634015	0,9848077530	0,17364817766689
9	1,5707963267		-3,49148336110938
10	1,7453292519	0,9848077530	-0,17364817766690
11	1,9198621771	0,9396926207	-0,34202014332570
12	2,0943951023	0,8660254037	-0,50000000000000
13	2,2689280275	0,7660444431	-0,64278760968651
14	2,4434609527	0,6427876096	-0,76604444311901

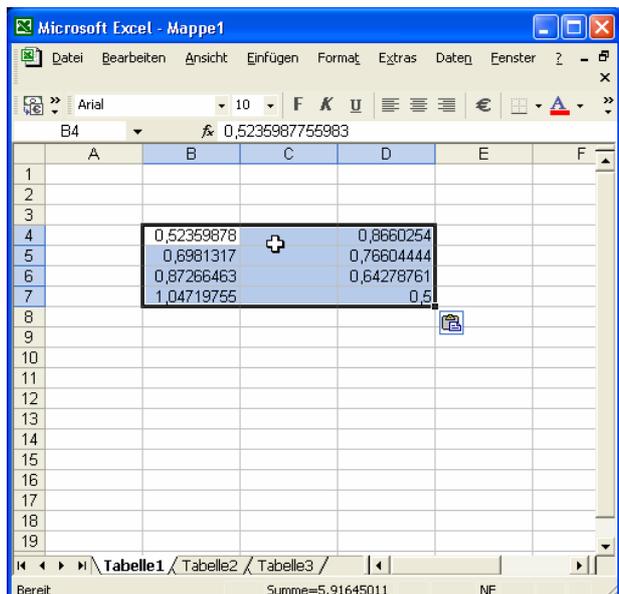
For example you can mark some ranges within the *Data Table* of **Plot**. Now you might need these values for a special calculation in Excel™.

Thus just copy the selection to the clipboard and open Excel™. Using the Edit Paste option of excel you can insert the values on any place desired within the Excel worksheet.

The same can also be done with word processors as e.g. Word™.

Of course the other way around does also work. **Plot** is able to paste any text containing numbers to the table. It will take the lines of the text as rows of the table and anything in between numbers as column separators.

Please refer to chapter 4.4.2 on page 37 to learn how to copy the graph and rich text report to the clipboard.

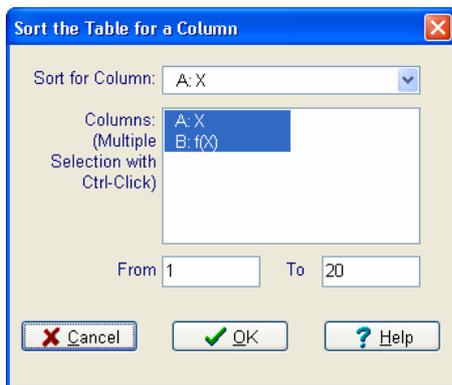


	A	B	C	D	E	F
1						
2						
3						
4		0,52359878		0,8660254		
5		0,6981317		0,76604444		
6		0,87266463		0,64278761		
7		1,04719755		0,5		
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						

Please note that the program uses the current Windows™ country settings of decimal separator and list separator to do this task. If you have problems with these functions on other programs it might help to set the decimal separator to “.” And the list separator to “,”, restart the program and try again.

3.2.3 Sort for a Column

In some cases the data you entered or imported to the table do not have ordered X-Values. This will result in a puzzled Graph if you use lines between the points. To help you to sort the table the  **Table – Sort** function can be used.



The first line will show the first column containing data of the table or the first column of the marked range. This column will be used to do an ascending sort. It can be changed to any column containing data.

Below a list of all columns of the table containing data is shown. This list gives the columns which will be sorted. The **Sort for Column** however will be always sorted whether selected or not. Firstly all the columns or the marked columns of the table are selected. You can select or deselect any column in this list. Thus sorting of non consecutive columns is possible.

Please note that you can select/deselect any item in this list without changing the other item selections using **Ctrl** Mouse - Click.

With the **From** and **To** fields you can enter the start and stop row to sort for. Clicking the  -button will execute the sort process and show the newly sorted table. If there are linked Graphs the display will be automatically updated.

3.2.4 Table Functions

Some of the functions available within the Table sub menu have already been described as **Table – Create Graph** (chapter 3.1.2 on page 13), **Table – Date-Time Column** (chapter 3.1 on page 9) **Table – Edit Formula** (chapter 3.1.1 on page 11) and **Table – Sort** (chapter 3.2.3 on page 16). The other functions deal with inserting and deleting parts of the table and navigation. Please also refer to Table 4 on page 11 for keyboard functions modifying the table.

Selecting **Table – Insert Cell** will put one empty cell at the active cell position and move all the cell values inside the actual column one row down. All other columns will be kept unchanged unless they are calculated “live” columns.

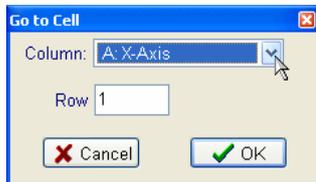
Table – Insert Row will insert a complete new row at the position of the active cell row. All the cell values within higher rows in all columns will be moved one row down.

Table – Insert Column inserts a new column at the position of the active cell. All existing columns are moved one column right starting with the active column. If moved columns do contain “live” calculations, the formula referring to the columns are modified accordingly.

Table – Delete Column does delete the whole column at the place of the active cell. All existing columns are moved one column left starting with the one right to the active column. If moved columns do contain “live” calculations, the formula referring to the columns are

modified accordingly. If a formula refers to the deleted column, this will be noted at the position of the reference within the formula.

Please note that rows and ranges of cells can be deleted by marking a row or range and deleting using **Del** (see Table 2 on page 10).



For an easy navigation within the table the **Table – Go to Cell** function was implemented. With the column drop down selection the **Column** position can be set. The **Row** position can be set within the relevant edit field. Clicking **OK** will position the active cell at the new column and row.

3.2.5 The Options Submenu

The **Options – Program Options** dialog holds some settings normally only changed once after installing **Plot**.



With the **Language** group you can select the language of the program user interface and the help file. The setup program has also a language selection which will set the language accordingly.

The **Toolbar Icons** group you can set the size and coloring of the toolbar icons accordingly.

With the **Last Outfit** group you can change the behavior of the program at start up. Selecting **Restore from last session**, will restore all the table and graph settings as you have done before you closed **Plot** on your last program session.

Choosing **Reset to default on start** will reset the

table and the graphs to a setting as if the program was freshly installed each time you start **Plot**.

The **Graph Windows** group holds information about the behavior of the graph windows displayed and newly created. If you check **Set all to same fixed size**, the graph windows will not be sizable and will have a fixed size of the width and height values entered below. This option has been implemented to enable you to have reports with graphs included that always look similar in size. If unchecked all windows are sizable to your needs but you have to take care for yourself how the graphs look in the report.

3.2.6 The Window Submenu

Sometimes it is not easy to find the correct window especially if many graphs have been assigned. Thus all the *Graph Windows* and the *Data Table* do contain a **Window** sub menu. The sub menu lists the titles of all *Graph Windows* and the *Data Table* as sub items. Thus selecting the desired window will activate it instantaneously.

3.2.7 The Help Menu

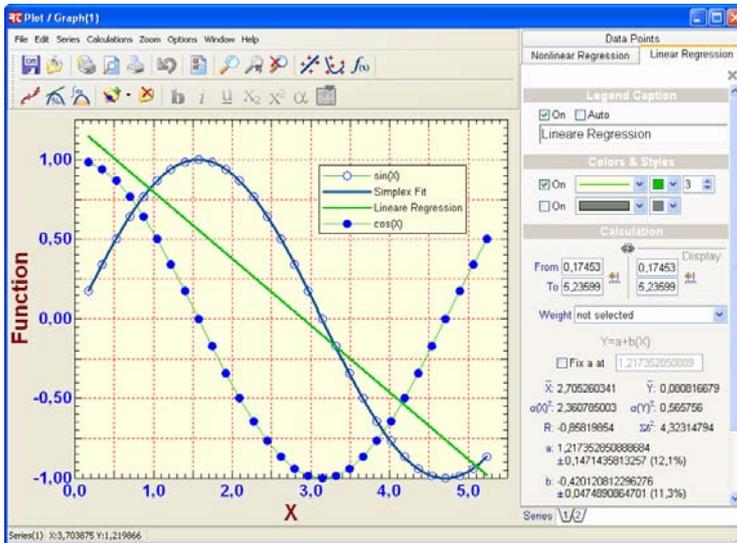
As usual under Windows™ pressing the **F1** function key opens the help window containing the item most relevant to the current position in the program. In some sub-menus this can also be executed clicking the  **Help** button. The contents page of the help file is always reachable with the  **Help – Contents** option. The search facility of the help system is reachable via  **Help – Topic Search**.

With the trial version, the  **Registration** option will be also available in this menu (see chapter 1.5 on page 4).



The last option contained in the sub menu is the  **About...** option. A pop up window gives some copyright information and gives you the actual version and release number. The username and the serial number are also visible. Please note these data if you need any support via e-mail. Your mail program will be opened with the correct address by clicking to the included link.

4 Graph Window



Plot can generate an unlimited number of graphs with the assigned series data of the *Data Table* (see chapter 4.1.1 on page 20). Each graph can contain an unlimited number of data series. The *Graph Window* has four major parts.

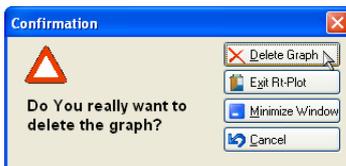
At the top, the menu and toolbar give access to the program options.

At the right the *Options Tab Control* gives quick access to calculation parameters and results and enables you to alter the line styles and point types of the

series and calculated lines. The *Series* tabs at the right bottom give you the ability to choose the active series. This is the source for adding new calculations and the display of the already generated calculation line results. The different calculation results and parameters and the data point properties can be shown selecting the appropriate tab at the right top.

The major middle part shows the plot with all its axis, grids, lines points etc.

At the bottom line a status bar gives information about the data point of the active series. You can move around the mouse within the graph. The status line will display the actual coordinates respectively. Pointing to a data point of the active series will show the index number to the table. Clicking to the data point will adjust the active cell to the Y-Axis value of the data series point within the *Data Table*. This feature will help you to find values which are outward the others, and correct wrong entries in the table.



If you want to delete the current Graph Window, you can click the Windows™ close-symbol in the right top corner. A small pop up window will ask you whether you really want to delete the graph. Clicking the **Delete Graph** -button will finally erase the window with all its series and calculations.

4.1 Settings for Data Series

The data of the graph are organized with point series. Each series can be assigned to X- and Y-values within the *Data Table*. The data points can be presented by lines, areas and symbols. The following chapters will explain the settings in detail.

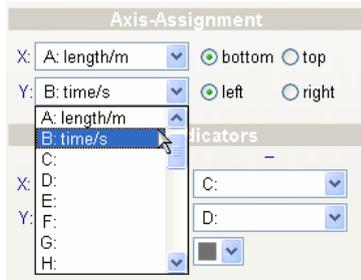
To create a new point series you can use the **Series – Add Series Tab** function. You can choose between four different types of series: **Line and Pointsymbols**, **Bars**, **Arrows** and **Bubbles**.

You can select the series you want to work with using the relevant tab.

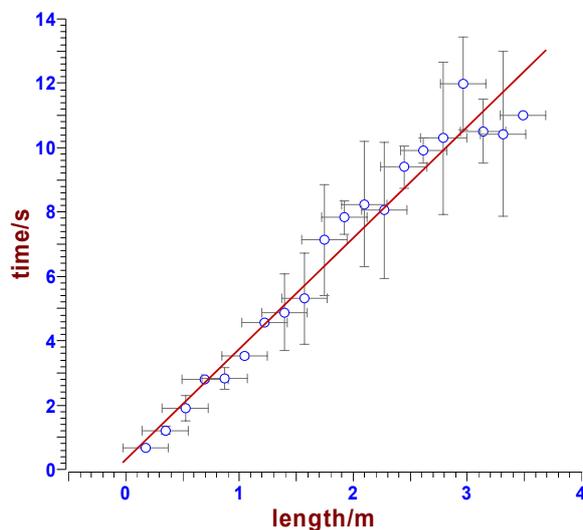
If you want to delete the currently selected series and all related calculations, you can use the **Series – Delete active Series** function.

All settings related to the series itself are made selecting the **Data Points** tab in the *Options Tab Control* on the right side of the window.

4.1.1 Assigning Columns to Values

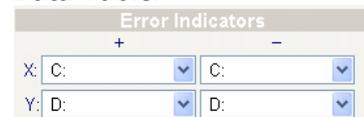


The X- and Y-values for the data point series are stored in the *Data Table*. A drop down selection list shows all columns available. You can link the X- and Y-values to any column using this controls. Single columns can be the source for multiple series. At the right side you can select the primary axis (bottom, left) or secondary axis (top, right) for displaying the point series. This makes it more easy to compare series with differing ranges using primary for one and secondary for the other.



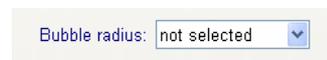
Mostly experimental data show some uncertainty. Therefore, with the **Line and Pointsymbols** series, error indicators are helpful to show the limits of confidence for each data point. These little lines can point to the lower (-) and higher (+) range of the X- and Y- Values. The uncertainty-values for each point in each direction can be entered or calculated with the *Data Table*.

The assignment can be done using drop down selections for each side. If no error indicators are needed just keep “not selected”.



Similarly with the **Arrows** series you can define the columns to be used to give the differences in X/Y coordinates to the tip of the arrow defining the length and directions of the vector field.

The **Bubbles** series uses a similar selection to be used for the radii of the bubbles.



4.1.2 Captions in the Legend

Each data point series and each calculated line can have an entrance in the legend to the graph (general settings see chapter 4.2.3 on page 26). The visibility of each item can be controlled by the **On** -checkbox. If the **Auto** –checkbox is selected the caption will be generated by **Plot** giving numbered descriptions as “Series(1)...Series(n)” and for calculated lines e.g. “Linear Regression from Series(1)” etc.. If **Auto** is deselected, you can enter any caption you want below. This edit field does support extended formatting (see chapter 2.3.4 on page 8).



4.1.3 Setting Styles of the Series Lines

The **Line and Pointsymbols** data series and calculated lines can be drawn with different line styles and colors and with different point symbols. Thus at the top of the **Data Points** tab and the calculation tabs the **Colors & Styles** can be set.

Line and Pointsymbols Series

The top line gives you the opportunity to alter the line between the data points or the calculated line respectively. With a check box you can switch on/off the display of the line. The line style combo box can change the line style and the corresponding color picker can change the color (see chapter 2.3.2 on page 7). Besides you can change the thickness of the line using a spin edit.



Please note that if you want to show non solid lines in the graph, the width or thickness of the line must be set to a value of 1 or 0! The Windows™ graphic drivers are not capable to display non solid lines with width higher than 1.

Within the next line you can define the area below the line until the zero line. This can give a up and down hill display of the functions. The area is combined with the background color (XOR) thus giving different colors with overlapping functions. With a check box you can switch on/off the display of the area. The style combo box can change the filling style and the corresponding color picker can change the color.

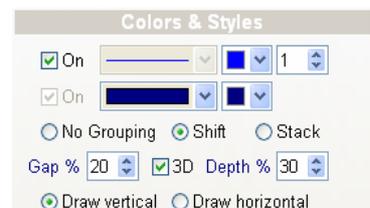
With a check box you can set the visibility of the symbols. The point symbols type can be altered with the relevant drop down selection. The spin edit at the right will set the size of the symbols.

The **Error Indicators** color picker combo box can be used to alter the color of the lines used to indicate the range of uncertainty for each data point. These however can only be shown if any column was assigned to an error value (see chapter 4.1.1 on page 20).

Bars Series

Beside setting the colors for the outlines of the bars and the filling color of the bar you can select whether the bars are displayed flat or with **3D** layout if the relevant check box is selected. If the style is 3D you can specify the depth of the bar in % of the class width with the relevant **Depth %** field.

The **Gap %** field contains the distance between the classes of the bars.



If more than one bar series are defined. The bars can be grouped in different ways. If the **Shift** radio button is selected the bars will be drawn side by side. If the **Stack** radio button is selected the bars will be drawn on top of each other.

Normally the bars will be drawn vertically using the X-axis for the classes of the bars and the Y-axis for their length. Thus **Draw vertical** would be selected. If you want the bars to be drawn horizontally with their length indicated by the X-axis and the classes at the Y-axis you can select the **Draw horizontal** radio button.

Arrow Series

The arrows have a solid tip which can be modified in **Length** and **Width** using the relevant input fields.



Bubbles Series

The bubbles can be drawn as circles ignoring the X-axis dimension. If the **Elliptical** check box is selected the dimension of the X-axis will be taken for the width of the radius and the Y-axis for the height of the ellipsis.

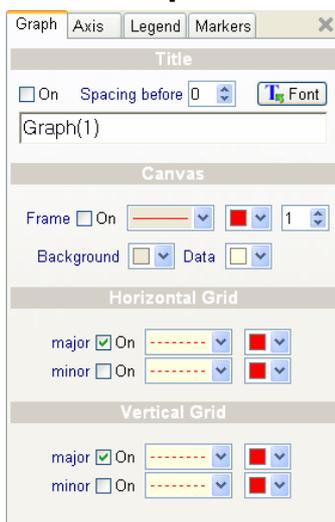


4.2 Setting Outfit Parameters

To alter all the options related to the outfit of the plot, the axis or the legend of series, you can enable the relevant option tabs using the **Options – Graph, Axis and Legend Parameters** function. The options related to the different tasks are placed at different pages reachable by the relevant tabs at the right side of the *Graph Window*. Clicking the function again or selecting the close symbol at the right top of the tab page will disable the Graph, Axis and Legend tabs and show the series options again.

All the changes made to the option tabs are displayed instantaneously with the graph. If you made a mistake with some parameter the **Edit – Undo** function will be very helpful.

4.2.1 Graph Outfit



The **Graph** tab page of the *Parameters Window* contains all parameters influencing the outfit of the plot itself. In the top line the **On** check box switches on/off the display of the title at the top of the plot. With the spin edit right to it you can set the spacing between the title and the top border of the graph. If you want to set the distance between the title and the top axis of the plot you can use the relevant field inside the **Gaps** frame within the **Axis** tab page selecting the top axis (see chapter 4.2.2 on page 23). The font used to draw the title can be altered clicking at the **Font** -button using the standard Windows™ font dialogue.

The title text can be edited below using the extended edit options (see chapter 2.3.4 on page 8).

The **Frame** line contains a check box to switch on/off a frame line around the whole plot. The type, the color and the line width can be set with the relevant combo boxes and the spin edit (see chapter 2.3.2 on page 7).

Please note that if you want to show non solid lines in the frame, the width or thickness of the line must be set to a value of 1 or 0! The Windows™ graphic drivers are not capable to display non solid lines with width higher than 1.

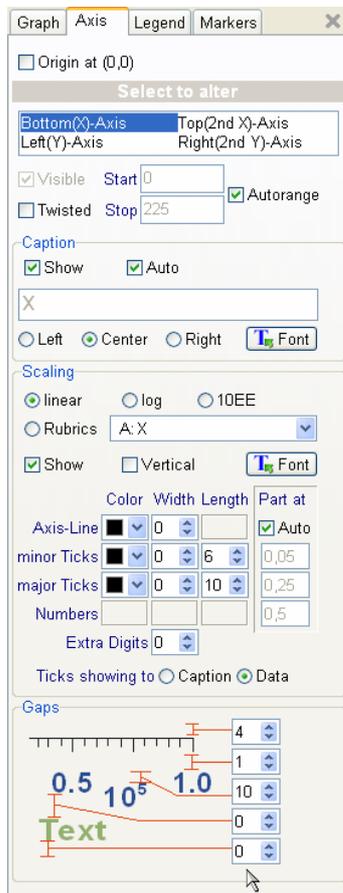
The **Background** color of the graph can be selected below. If the **Data** color is equal to the background color a change of the background color will alter both. The **Data** color means the background color of the area where the data point are displayed.

Choosing different colors for the both backgrounds can generate a nice layout as in the example at the beginning of the chapter at page 19.

Choosing the color "Button Face" will give a plot with a transparent background in the report and the exported graph (see chapter 4.4 on page 35 and chapter 4.4.2 on page 37).

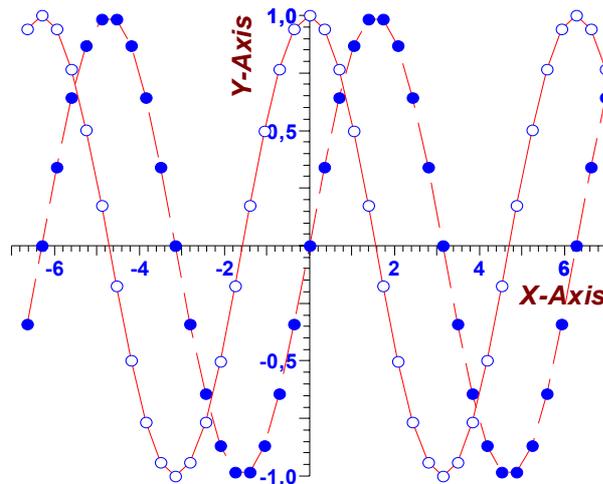
Below, a grid with horizontal and vertical lines at the positions of the axis minor and major tick marks can be selected. The lines can be switched on/of by the relevant check boxes and the line styles and colors be set with the corresponding combo boxes.

4.2.2 Axis Outfit



The **Axis** tab page of the Parameters Window contains all parameters influencing the entire axis.

At the top line a check box enables/ disables the display of the axis with origin at zero. This means the plot can have a classical mathematical outfit.



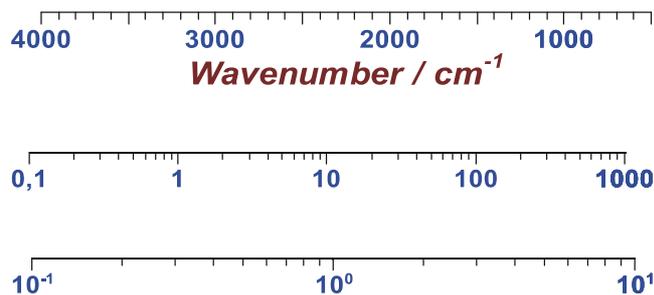
Below the **Select to alter** -section is placed. At the top the axis can be selected which will be altered by the various options below.

Within the selection list you can do multiple selections using the **Ctrl** mouse click or drag selection features:



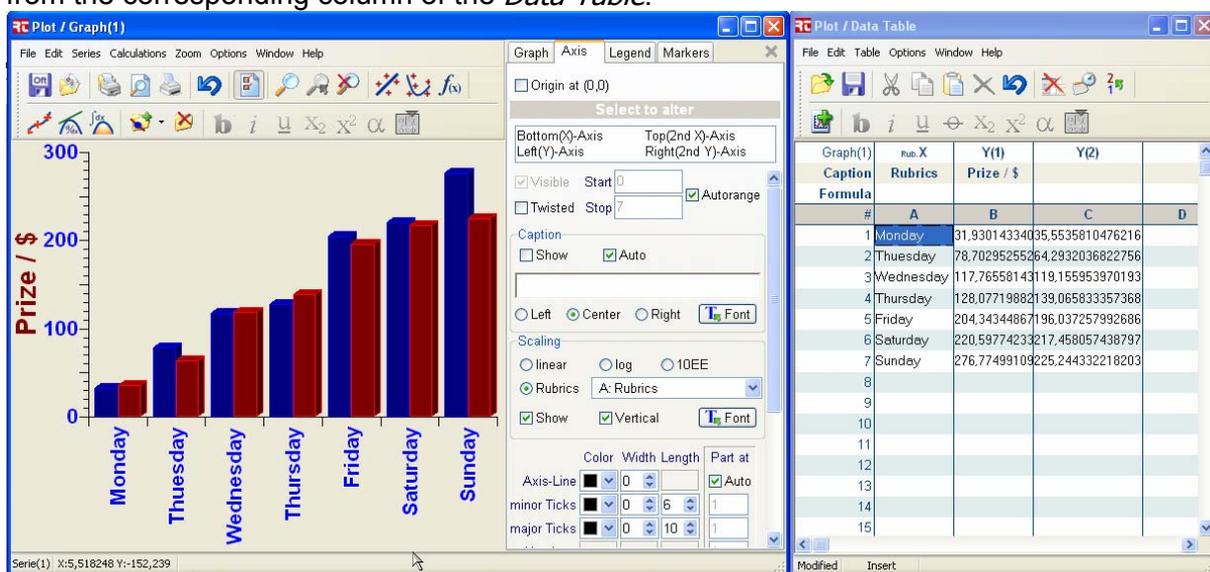
This helps you to set the parameters for more than one axis synchronously. All the controls inside the frame will change the parameters of all the axis currently selected. The presets will be set according to the axis selected the last.

Checking **Twisted** will generate axis with an unusual direction. This means horizontal axis will have low values more to the right and vertical axis more to the top. This setting e.g. makes sense for plotting infrared spectra using wave numbers as units.



With the **Scaling** radio button selection you can define linear **lin.** and logarithmic scaling with the axis. **log** means the scaling numbers will have normal formatting, **10EE** means the numbers use exponential format.

The last selection **Rubrics** will take the scaling labels from the captions which are retrieved from the corresponding column of the *Data Table*.



If the axis was assigned a date-time column the axis will automatically display the date or time scaling. Other selections are impossible. You have to switch back the date-time column to normal, to display other scaling again (see chapter 3.1 on page 9).



It is highly recommended to keep the **Range** option checked as **Auto**. This means the axis start and stop values are automatically adjusted to the actual minimum and maximum of all the assigned graph series. If you uncheck the **Auto** option you can alter the **Start** and **Stop** values of the axis using the relevant edit fields.

You do not need to disable the auto ranging if you want to zoom into special value areas of the graph. This can be better achieved using the zooming options (see chapter 4.4.3 on page 38).

Below the settings related to the captions and the scale numbers are placed. In the **Caption** line you can modify the behavior of the caption to the axis. The **Show** check box controls the

display of the caption. If a vertical axis was selected, the **Horizontal** check box gives you the ability to alter the orientation of the caption.

If the **Auto** check box is checked, the caption of the axis will be taken from the column header of the assigned axis column in the *Data Table* (see chapter 3 on page 9). Otherwise you can enter any axis caption within the relevant edit field below using the extended format options (see chapter 2.3.4 on page 8). This caption however will not be updated if any changes are made in the column headers of the *Data Table*. The font used to draw the caption can be altered clicking the **Font** -button, using the standard Windows™ font dialogue. Below 3 radio buttons give you the choice to align the caption **Left** (bottom), **Center** or **Right** (top).

With the **Scaling-Numbers** line the **Show** -check box enables/disables the display of the scaling number text with the axis. This might be useful if you want to have axis at the top and right, but not want the graph to be overloaded. The font used to draw the numbers can be altered clicking the **Font** -button at the right.

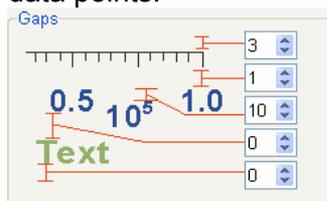
Below in a small table you can set the axis line, the major ticks and the minor ticks color, thickness and length.

If the **Auto** check box in the last column is enabled automatic setting of the positions of the ticks and scaling numbers. It is highly recommended to keep the automatic switched on. Nevertheless the position values can be set using the appropriate edit fields if **Auto** is deselected. The position values always refer to the normalized value of the axis scale. This means no matter what start and stop values actually exist, the axis is treated as it was displaying values in the range 0...10, calculating the tick positions at the position matching the values as dividers.

If you want to alter the automatic part settings permanently, please refer to Appendix A.

If the radio button **Ticks showing to Caption** is selected, the tick lines will point to the caption relative to the axis line, as in the above examples.

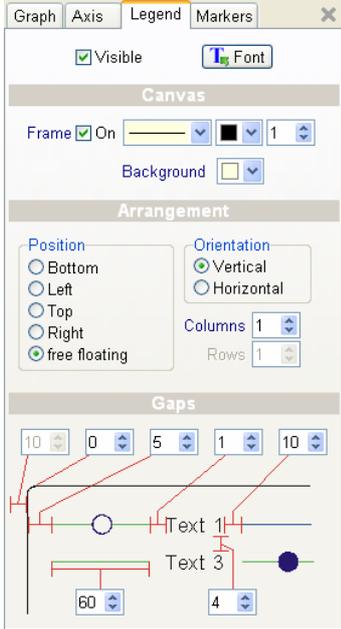
If **Ticks showing to Data** was selected, the tick lines will point the opposite way to the data points.



Below the **Gaps** -frame shows a symbolic representation of the axis and the gaps separating the different objects forming the axis. Red lines will link the distances to the relevant edit fields.

The additional Exponent at the scaling will be only displayed if the range of stop value of the axis does fit the exponentials -2 to 3. This means values $\leq 10^{-3}$ or $\geq 10^4$ will show the additional exponent and normalize the scaling numbers accordingly.

4.2.3 Legend Outfit



If you have a graph with lots of data point series and calculated lines you surely want to add a legend to the graph with captions related to the different line and point styles. The **Legend** parameters can be altered using this tab page of the *Parameters Window*.

The **Visible** check box enables/disables the drawing of the legend box inside the graph. The font used to draw the captions can be altered clicking the **Font** -button, using the standard Windows™ font dialogue.

Inside the **Canvas** region settings related to the whole drawing area of the legend are placed.

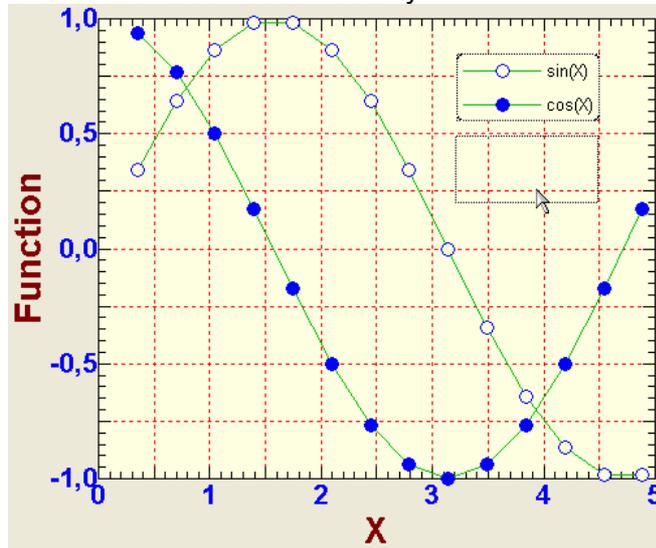
Checking the **Frame On** will draw a frame line around the legend box. With the corresponding line style and color combo box and thickness spin edit, you can specify the lines outfit (see chapter 2.3.2 on page 7). The **Background** color combo box sets the background color of the legend box.

If you set the color the same as the data area (see chapter 4.2.1 on page 22) this color will change automatically to the data area color if this was changed.

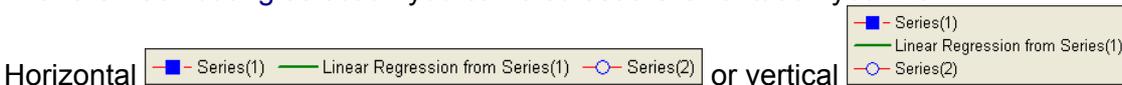
The legend can be drawn at different positions, centered at the borders of the four possible axis or free floating inside the graph at any position you like.

The **Position** can be changed with the relevant radio buttons group. Selecting a horizontal axis as **Top** or **Bottom** will also set the **Orientation** of the grouping of the legend items **Horizontal**. Choosing **Left** or **Right** will set **Vertical** orientation automatically.

If you select **free floating**, the legend can be dragged to any position in the graph. To drag the legend you must move the mouse cursor to the legend, press the mouse left button until you see the drag frame. Keep the mouse button pressed and move the frame to the desired new position. When the mouse button is released, the legend will be drawn at the new position.

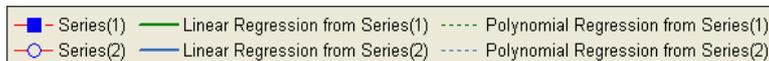


With the **free floating** selection you can also set the **Orientation** you like:



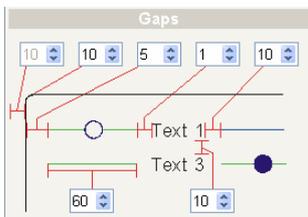
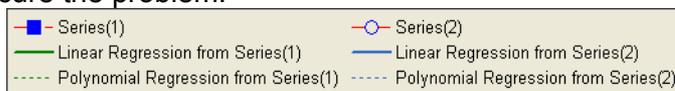
Depending on the **Orientation** you can alter the number of **Columns** and **Rows** available for grouping.

This option was implemented



because if you have many series visible, the legend captions might not fit into one row horizontally. Thus setting more rows will cure the problem.

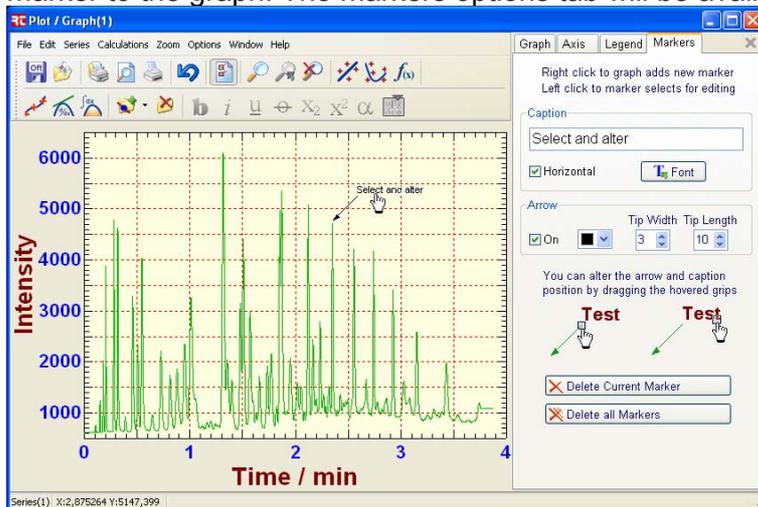
With a **Vertical Orientation** and **Columns = 2** this will look like this:



Below in the **Gaps** region a symbolic representation of the axis and the gaps separating the different objects forming the legend is shown. Red lines will link the distances to the relevant edit fields.

4.2.4 Adding Markers and Captions to the Graph

If you right click to the graph a pop up menu will appear where you can select to add a new marker to the graph. The markers options tab will be available for settings at the right.



The caption to the marker can be edited at the top field.

The caption can be drawn horizontally or vertically by not checking the **Horizontal** check box. The caption can be displayed in any windows **font** selectable with the relevant button.

The display, the color, the width and the length of the tip can be adjusted below.

You can add as man markers you like right clicking to the graph. You can drag around the marker if you see the hand

mouse cursor. The currently selected marker can be altered at the right tab.

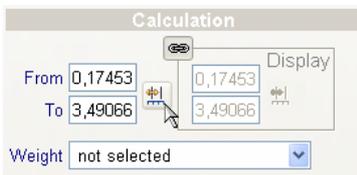
If the mouse points to the start of the arrow a grip will hover. This grip can be used to adjust the length and direction of the arrow with the mouse. At the other end of the caption a grip hovers to be used to adjust the position of the caption in relation to the arrow start.

The **Delete Current Marker** button can be used to erase the currently selected item.

The **Delete Current Marker** button can be used to erase all the markers in the graph.

4.3 Adding calculated lines

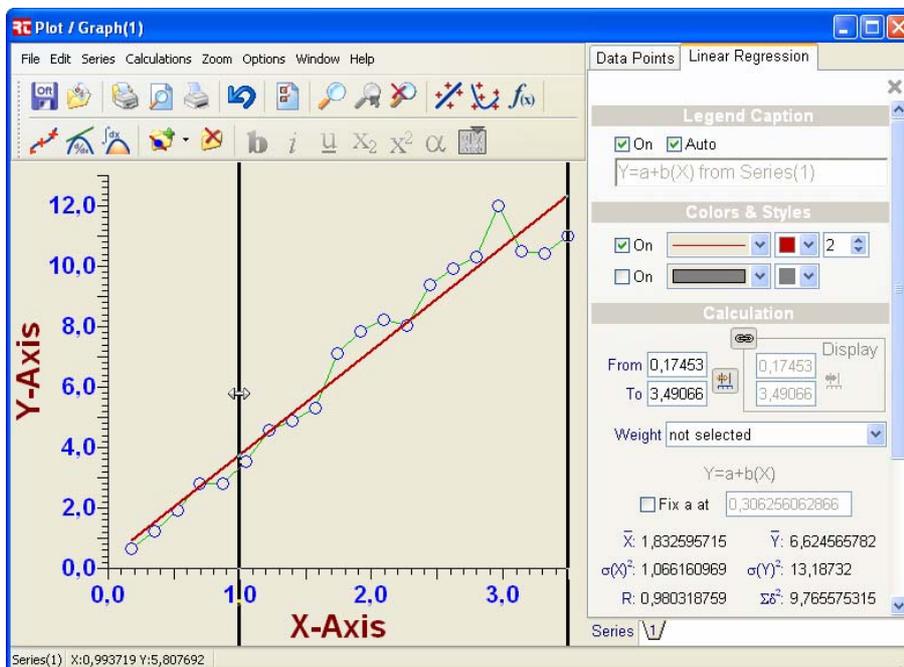
The calculated lines can be added to the graph using the **Calculations – Add...** menu functions or the toolbar . This will create the newly calculated line with the data points of the active data series as source. Adding a calculation will also add a new tab to the *Options Tab Control* of the *Graph Window*. You can add an unlimited number of calculation lines to the graph using different calculation ranges or parameters – also with the same calculation method. This chapter describes some of the functionality common to all the calculations. A detailed description of each calculation tab will follow. To delete a calculation line and its options tab, you can activate the relevant tab and use the **Edit – Delete selected calculation** menu function or click the close button at the right top corner. The selection of the line properties was already explained in chapter 4.1.3 on page 21.



The calculations can use statistical weights to calculate the lines. This means you can give each single data point more or less influence on the calculation. If a data point has a weight of 0, it will not influence the calculated line at all. A higher value will take the specified data point as it was **Weight** times contained with the calculation. If no **Weight** column is selected

calculations use an equal weight of 1 for each data point.

As the calculation line is newly added, the range of the calculation will include all the values of the related data points. It might be necessary to limit the calculation to a certain range of X-values. This can be achieved entering the range to the appropriate **From** and **To** fields. You can choose the range interactively using the range markers. The markers are made visible clicking the appropriate  button.

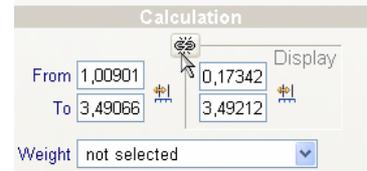


The graph now shows two vertical lines indicating the **From** and **To** positions for the calculation. You can drag each of the two lines to the position which most suits the needs for the calculation. Clicking again the  button will take the new range to the edit fields and hide the markers again. The calculation will be executed again automatically and the modified results will be displayed inside the tab.

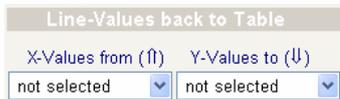
If the **From** position is set lower or equal the lowest value of the data points of the actual series, the start position is set to auto ranging. This means that adding new values to the series lower than the actual value, will automatically also modify the **From** value of the calculation and automatically update the results. Analogously choosing a **To** position higher or equal the highest value of the data points, will set the stop to auto ranging.

As in the above example the display range of the line is identical with the calculation range. This is indicated by the chain symbol in the depressed button between **Calculation** and **Display** and disabled edit fields inside the **Display** frame.

If you need to have a different display range, e.g. to extrapolate values this can be achieved by clicking the  button or clicking inside the frame. Afterwards the edit fields are enabled for input. Also this range can be set interactively using the range markers, made visible by the  button, as described above.



You can enable the coupling of the Calculation range with the Display range by clicking again at the  button. This will synchronize again the **From** and **To** values.



At the very bottom of the calculation tab the **Line-Values back to table** area shows column references that can be used to show results of the calculated line in the data table. This option will be useful e.g. in cases you need interpolated point values at specified X-Values. With the **X-Values from** selection you can specify any column of the table to be used as X-Values copying the Y-Results of the formula from the current calculation to the column specified with the **Y-Values to** selection. The Y-Values will be calculated for all the X-Values in the table column until the **Display To** value is reached.

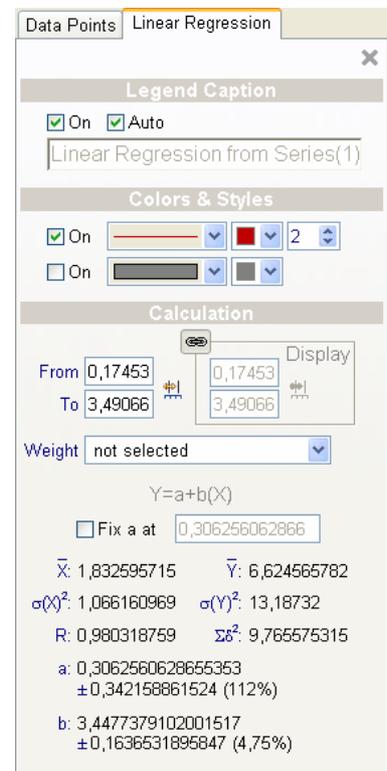
4.3.1 Linear Regression

Many processes in science can be expressed by straight line equations $Y=a+bX$. Thus it is a quite common task to draw straight lines passing the experimental data points. The slope and the intercept of these lines are often used to calculate physical constants etc..  **Plot** can calculate these regression lines using the least squares method (see Appendix B on page 48 for formula). This is done using the  **Calculations – Add linear Regression** menu option.

As described above the calculations will be processed with the data points of the active data series using the assigned column values for X-data Y-data.

In some cases it is preferred to calculate the line using a known intercept a . This is the case e.g. when theory says that the line must cross zero. To fix the offset a , you can check the relevant **Fix** check box and enter the value of a to the edit field at the right.

All the results are displayed below. The result parameters as the means \bar{X} and \bar{Y} , variances $\sigma(X)^2$ and $\sigma(Y)^2$, correlation coefficient R , sum of residuals $\Sigma\delta^2$, intercept a and its error, slope b and its error can also be included in the printed report (see chapter 5.3 on page 44).



 **Plot** does also calculate the linear regression if one or both axis are set to logarithmic scaling. The regression formula will be altered to $Y=a+b(\lg(X))$; $\lg(Y)=a+bX$ and $\lg(Y)=a+b(\lg(X))$ accordingly.

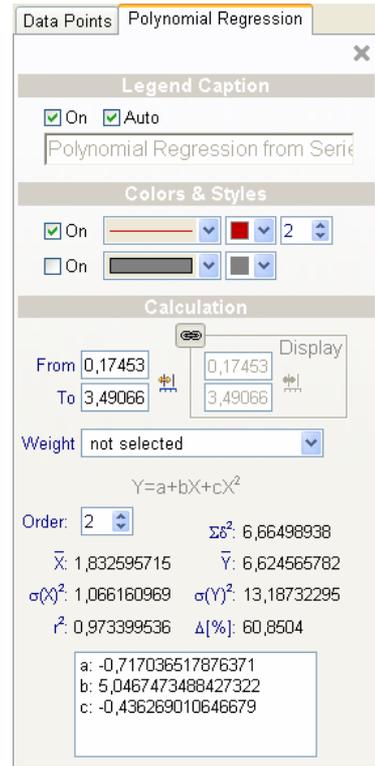
4.3.2 Polynomial

In some cases it is better to apply a regression calculation giving the least squares fit for a polynomial $Y=a+bX+cX^2+\dots$ [1].

 **Plot** can calculate these regression lines using the  **Calculations – Add Polynomial** menu option.

As described above the calculations will be processed with the data points of the active data series using the assigned column values for X-data Y-data.

The order of the polynomial to be calculated can be set using the **Order** spin edit. The sum of residuals $\Sigma\delta^2$ is shown right to it. All other results are displayed below. The result parameters as the means \bar{X} and \bar{Y} , variances $\sigma(X)^2$ and $\sigma(Y)^2$, probability r^2 , relative error of coefficients $\Delta[\%]$ and the coefficients a , b , $c\dots$ can also be included in the printed report (see chapter 5.3 on page 44).



Polynomial Regression

Legend Caption
 On Auto
 Polynomial Regression from Serie

Colors & Styles
 On Auto
 On

Calculation
 From: 0,17453 To: 3,49066
 Weight: not selected
 Equation: $Y=a+bX+cX^2$
 Order: 2 $\Sigma\delta^2$: 6,66498938
 \bar{X} : 1,832595715 \bar{Y} : 6,624565782
 $\sigma(X)^2$: 1,066160969 $\sigma(Y)^2$: 13,18732295
 r^2 : 0,973399536 $\Delta[\%]$: 60,8504

Results:
 a: -0,717036517876371
 b: 5,0467473488427322
 c: -0,436269010646679

¹ P. Bewington, data Reduction and Error Analysis, Mc Graw-Hill, New York (1984)
 G.L. Squires, Messergebnisse und ihre Auswertung, de Gruyter, Berlin (1971)
 W.H. Press, Numerical Receptions in Pascal, Cambridge University Press (1989)

4.3.3 Non linear Regression

Many times the formula presenting the physical law might be a non linear function. In such a case the calculations cannot solve the equation system giving the least squares function. Thus an iteration algorithm is applied varying the parameters of the function to fit a minimum of variations from the data points. **Plot** uses the Simplex algorithm to do the non linear fit^[1].

If you add the calculation tab using the **Calculations – Add nonlinear Regression** a combo box $Y(X)=$ will give you the ability to choose a function to fit from the history pull down list or enter a new formula.

The syntax is nearly the same as used for calculating columns with the *Data Table* (see chapter 3.1.1 on page 11).

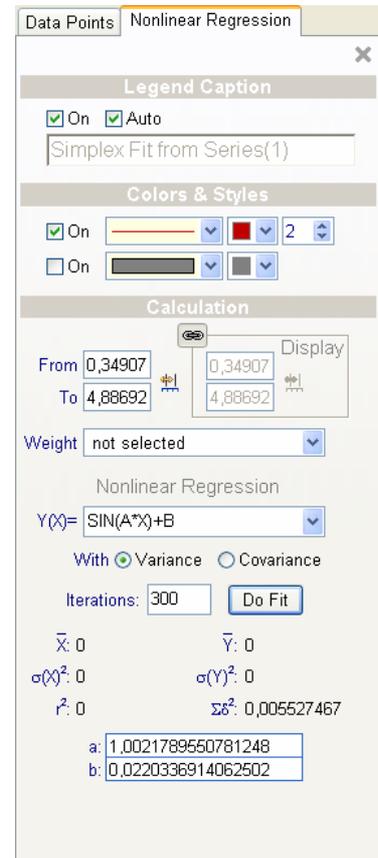
The formula can contain several operators compatible to BASIC or PASCAL syntax with the addition of the power operator, \wedge . Case is not significant when matching function names or the 'E' character used in scientific notation. Spaces and tabs are ignored.

The grammar follows the normal rules of arithmetic precedence, with \wedge highest, $*$ and $/$ in the middle, and $+$ and $-$ lowest. Thus $1+2*3^4$ means $1+(2*(3^4))$. Note that the power operator X^y is right-associative. Thus $2^{0.5^2}$ means $2^{(0.5^2)}$. All other arithmetic operators are left associative: $1-2-3$ is equivalent to $(1-2)-3$. Parentheses can be used to force non-default grouping. Trigonometric functions as $\sin()$, $\cos()$ etc. have radiant as argument, the reciprocal angle functions have radiant as result.

Please note that you must use the independent variable X at least once. The varied parameters must start with A continuing up to the last parameter needed.

Table 6: Syntax for Calculation of non linear Functions

Variables	
A...P	Parameters varied during the iterative fit, at least A must appear
X	The independent variable, must appear once
Operators	
+	Plus
-	Minus
*	Times
/	Divided by
\wedge	To the power of



¹ M. Avriel, Nonlinear Programming, Prentice Hall (1976)

Functions

abs()	Absolute value
arccos()	Inverse cosine
arccosh()	Inverse hyperbolic cosine
arcsin()	Inverse sine
arcsinh()	Inverse hyperbolic sine
arctan()	Arctangent
arctanh()	Inverse hyperbolic tangent
ceil()	Lowest integer greater than or equal to argument. The absolute value of argument must be less than 2147483647. For example: Ceil(-2.8) = -2; Ceil(2.8) = 3; Ceil(-1.0) = -1
cos()	Cosine
cosh()	Hyperbolic cosine
cotan()	Cotangent
DegToRad()	Degrees to radiant (same as: ())*pi/180)
exp()	Exponential (power to base e)
floor()	Highest integer less than or equal to argument. The absolute value of argument must be less than 2147483647. For example: Floor(-2.8) = -3; Floor(2.8) = 2; Floor(-1.0) = -1
frac()	Fractional part
int()	Integer part
ln()	Natural logarithm
lg(), log10()	Logarithm with base 10
log2()	Logarithm with base 2
RadToDeg()	Radiant to degrees
round()	Argument rounded to the nearest whole number. If argument is exactly halfway between two whole numbers, the result is always the even number. This method of rounding is often called "Banker's Rounding".
sin()	Sine
sinh()	Hyperbolic sine
sqr()	Square
sqrt()	Square root
tan()	Tangent
tanh()	Hyperbolic tangent
trunc()	Argument rounded toward zero

Constants

pi	3.14159...	π
cR	8.3143	Ideal Gas Constant [J/(K*mol)]
ck	1.38062e-23	Boltzmann Constant [J/K]
cVmol	22.4136	Molar Volume of ideal Gas [l/mol]
cNA	6.02217e23	Avogadro's Number [1/mol]
cG	6.673e-11	Gravitation Constant [N*m ² /kg ²]
cc	2.997925	Speed of Light [m/s]
ce0	8.8542e-12	Electrical Field Constant [A*s/(V*m)]
cmu0	1.2566e-6	Electrical Induction Constant [V*s/(A*m)]
ce	1.602192e-19	Elemental Charge [C]
cF	9.64867e4	Faraday Constant [C/mol]
ch	6.6262e-34	Plank Constant [J*s]
chq	1.0546e-34	Plank Constant /(2*Pi)

The list of physical constants can be altered and extended to your needs (see Appendix A on page 47)

Examples: $\text{Sin}(X*A)*B+c$ $A+B*\exp(c*x)$

Below the calculation formula you can specify whether you want to optimize the fit for a minimum **Variance** or **Covariance**. In most cases you will select the variance option, because this is the classical least squares approach. The theory is that the deviations in the result of the formula are not caused by uncertainties in the independent variable X . The optimization thus minimizes the sum of squares of distance of each resulted formula Y -value to the experimental Y -value. In some cases, especially with functions with steep and flat parts, the deviations in the steep part would always dominate the optimization. Thus you could think of applying a weighting function compensating these effects.  **Plot** gives you another

opportunity to solve this problem using the **Covariance** as optimization criterion. As the covariance is the product of the deviations in the X- and Y-directions of each point related to the calculated formula, the sum of the absolute values of covariance gives a better optimum. This approach would not overestimate any part of the function, resulting in visibly better fits. However the covariance should only be applied for the special functions mentioned above. You also must take care that the fitting function is monotone, because the calculation of the covariance needs a single X and Y function point related to one experimental point.

In most cases selecting Variance will give good results, thus it is the choice for the first try.

To execute the iterative fit you have first to specify the number of Iterations within the relevant edit field. Then you have to think about valid start parameters for the coefficients A...P. This is a difficult task, because you have to know the functionality well. Anyway you can alter the parameters anytime and redo the fit until you are satisfied. The iterations start clicking the **Do Fit** button. During the iterations the current values of the parameters will be updated. After the last iteration the calculated line will be displayed.

If you set the number of **Iterations** to 0, the parameters will not be varied at all. This means you can use this to evaluate the functions entered as a "Function Plotter".

4.3.4 Functions using Interpolation

The **Interpolation**, **Differential** and **Integral** functions all use a polynomial of third degree between each data point for the interpolation. The differential is calculated by analytically differentiating the interpolating polynomial. The integral is also calculated by analytically integrate the interpolating polynomial.

The interpolating polynomial is calculated according to an algorithm of Akima^[1] or as an approximating spline function^[2]. The applied method can be set with the relevant selection in the tab.



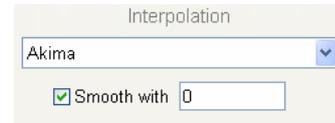
Akima's interpolation

The difference between Akima's interpolation and normal spline interpolation is that the second derivative of the interpolated curve is not steady. Thus also stepped curves can be interpolated without applying stiffness factors. The Akima interpolation formula does not apply statistical weights to calculate the interpolation function (see page 28). However you can use the assigned weights to indicate data points which should not be included in the interpolated line by setting the weight to 0. This will treat the point as not existing for the calculation. Data points with weights higher than 0 will be included into the calculation. Not assigning any weight, will take every point inside the calculation range for deriving the interpolating function.

¹ H. Akima, Journal of Assc. For Comp. Mach., **17**(4), Oct. 1970, pp. 589-602

² G. Engeln-Müllges, F. Reutter, Numerik-Algorithmen, VDI Verlag 7.Aufl. 1996, pp. 269

In some cases experimental data points have a lot of “noise” with them. This means the data fluctuate randomly around the expected functional. Therefore a smoothing function can be activated checking the **Smooth** box. The software will detect for each data point the points in the range $-\Delta X$ and $+\Delta X$. This distance can be entered in the **with** edit field.



Smoothing is only achieved if the distance is large enough to cover at least one different data point. The larger the distance the more values will be included in the average, giving a smoother line.

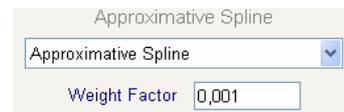
The smoothed values will be calculated according a moving average weighted by the distance of the average points. The advantage of defining a range instead of a number of moving average points is that a range also gives a smooth function in parts where the density of data points varies a lot.

$$Y_i^{smoothed} = \frac{\sum_{X_j \leq X_i + \Delta} (1 - |X_j - X_i|) Y_j}{\sum_{X_j \leq X_i + \Delta} (1 - |X_j - X_i|)}$$

Approximative Spline

As described above the spline interpolation will have a steady second derivative. The approximative spline interpolation function uses weights for the data points to calculate the interpolating polynomial. The higher the weights are, the more the interpolated function will be forced to pass the points. Thus, as the function is attracted by a magnet. High weights will force the spline to pass the point; low weights make a more stiff interpolation in between the points.

The weights used to derive the interpolation polynomial are taken from the assigned weights in the *Data Table* (see chapter 4.3 on page 28) and multiplied with the **Weight Factor**. If no weights have been assigned, the **Weight Factor** is used for every point.



4.3.4.1 Interpolation

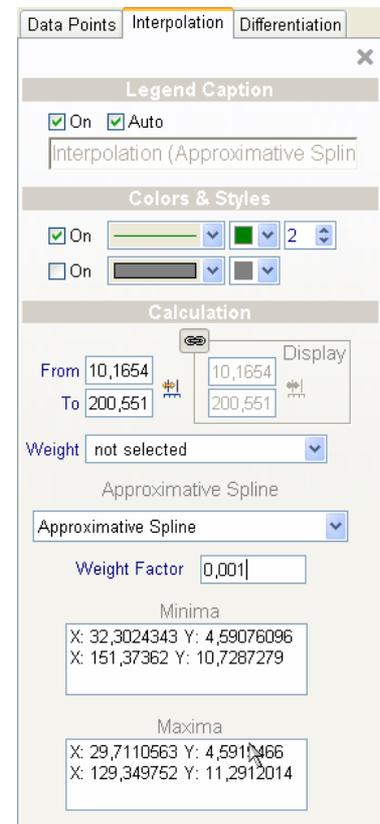
You can add an interpolation line using the  **Calculations – Add Interpolation** menu option. Smoothing is added as described above. The interpolated data points are displayed according to the selected polynomial interpolation function. Using this function also the local **Minima** and **Maxima** are found and displayed with the tab page.

4.3.4.2 Differential

You can add a differential line using the  **Calculations – Add Differential** menu option. Smoothing is added as described above. The differential data points are displayed according to the analytical differential of the selected polynomial interpolation function. Using this function also the local **Minima** and **Maxima** of the slopes are found and displayed with the tab page.

4.3.4.3 Integral

You can add an integral line using the  **Calculations – Add Integral** menu option. Smoothing is added as described above. The integral data points are displayed according to the analytical integral of the selected polynomial interpolation function. Using this function also the local **Minima** and **Maxima** of the integral are found and displayed with the tab page.



4.4 Menu Functions

As some of the functionality of the *Graph Window* was not described in the above the following chapters will list the missing options ordered as they appear in the main menu. The **Window** and the **Help** sub menus are identical to those already explained in the *Data Table* chapters 3.2.6 on page 17 and 3.2.7 on page 18.

4.4.1 File Functions

4.4.1.1 Loading and Saving Graph Outfits

Certainly you want to store the changes made to the graph lines and symbols, to be able to have your own design of your graphs. Thus the  **File – Save Outfit** option is implemented. If this item is selected, a standard Windows™ file selection dialogue enables you to enter a filename for the current graph outfit. After selection the outfit will be saved.

The other way around you can reload any outfit previously saved by selecting the  **File – Load Outfit** option. All the graph style settings will change according to the previously saved file.

4.4.1.2 Saving Reports as Rich Text Files

The graph and the calculation results are merged together using a template document (see chapter 5 on page 39). The resulting document can be saved using the  **File – Save Report** option. A standard Windows™ file selection dialogue enables you to enter a filename for the document. After selection the report will be saved using rich text format. This format can be read by most of the currently existing word processors e.g. WordPerfect™ or Word™. Thus this option can be used to archive the reports or send it to your colleagues who might not possess  **Plot** via e-mail.

4.4.1.3 Saving the Graph as Windows™ Metafile

This option allows saving the displayed graph as metafile. Selecting this option  **File – Save Graph** will open the standard Windows™ save file dialogue. There you can specify the filename the graph will be stored to. This file can be imported in many other programs e.g. Word™, Corel Draw!™, PowerPoint™ etc.

For normal use it might be faster to use the copy and paste method (see chapter 4.4.2 on page 37). But e.g. for large documents in Word™, with lots of graphs, it is better to use links to the graph files instead.

4.4.1.4 Editing the Report

The menu option  **File – Report** will open the *Report Editor*. This window enables you to alter the printed and exported reports by editing the related documents. Because this task needs some more extended explanations this has been moved to its own main chapter 5 on page 39.

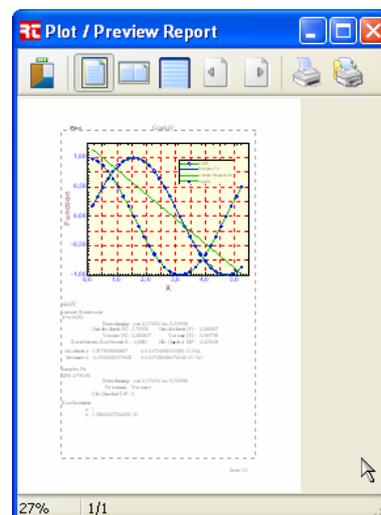
4.4.1.5 Printer Setup

Choosing the  **File – Printer Setup** menu option will open the standard Windows™ printer dialogue. There you can choose the printer for the report and set up its options.

4.4.1.6 Print Preview

The graph and the calculation results are merged together using a template document (see chapter 5 on page 39). The resulting document can be previewed using the  **File – Print Preview** option.

A small window shows how the report will look printed on paper. Within this window you can choose the view as full page, two pages and fit to width, select different pages to view and also set up the printer and print.



4.4.1.7 Print Report

The graph and the calculation results are merged together using a template document (see chapter 5 on page 39). The resulting document can be printed using the  **File – Print Report** option.

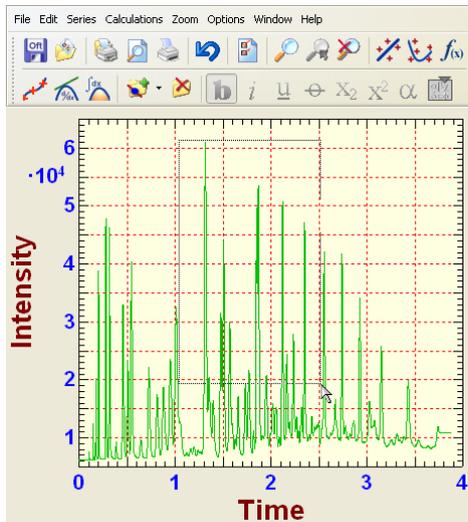
4.4.2 Clipboard Functions

As most other Windows™ programs  **Plot** also supports data transfer from program to program and input field to input field via the clipboard functions. This means if you have marked any text or number, this selection can be copied or cut into the clipboard and pasted to any program supporting clipboard functions. The functions are accessible via the **Edit** menu – **Cut – Copy – Paste** with the toolbar buttons    and the keyboard **Ctrl C**, **Ctrl X** and **Ctrl V**. If you don't have marked any text,  **Plot** will copy the graph as metafile into the clipboard. Thus the graph can be pasted to any other program running in parallel as e.g. PowerPoint using the **Edit – Paste** function of the called program. This option makes presentations including plots more easy.

You can also use the **Edit – Graph to Clipboard** option to copy the graph as metafile to the clipboard although you might have selected some number or text.

The **Edit – Report to Clipboard** will copy the complete report including the graph and the results to the clipboard using rich text format. Thus you can paste the complete report to another program as e.g. Word™.

4.4.3 Zooming Options



These menu points assist you to display selected data (zoom into the graph), toggle between different ranges and reset to the full graph display.

The most common method to zoom into the graph would be moving the mouse to one corner of the range of interest, press the left mouse button, keep the mouse button pressed and drag a frame to the corner where the range should stop. If the mouse button is released, the display will be immediately updated showing the new range. The old range will be memorized, ready to be taken with the **Zoom Back** function.

If you have problems positioning the mouse to the correct values or want to be more exact selecting the

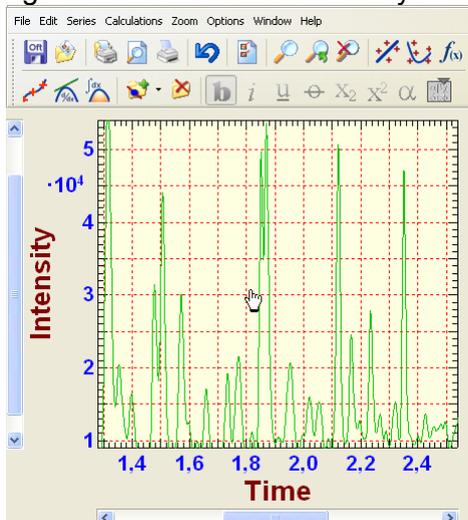
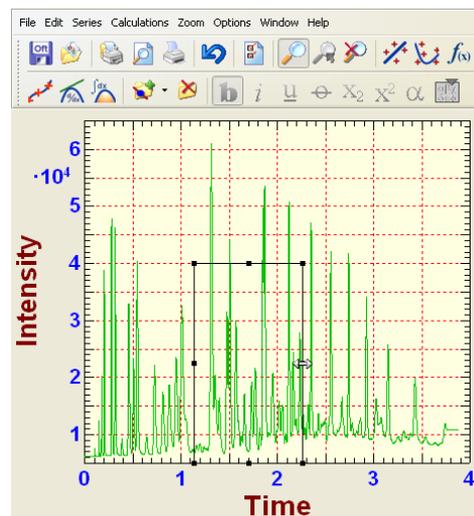
range a second method will be your choice.

If the **Zoom – Zoom In** menu option is selected a black rectangle with square black grips will show up, called seizer frame. The **Zoom In** option will be checked and the corresponding speed button will be depressed. You can move the borders of the frame dragging the seizer grips with the mouse to the desired position.

Pressing the speed button again or un-checking the **Zoom In** menu point will execute the new range for scaling. The old range will be memorized, ready to be taken with the **Zoom Back** function.

The **Zoom – Zoom Back** menu option will restore the range previously shown. The storage will use a circular scheme with reset to the first range when the last range was reached. Thus you can toggle between the different zoomed ranges.

The **Zoom – Show All** menu option will recalculate the graph; thus all data are displayed again. The zoom back memory will also be reset.



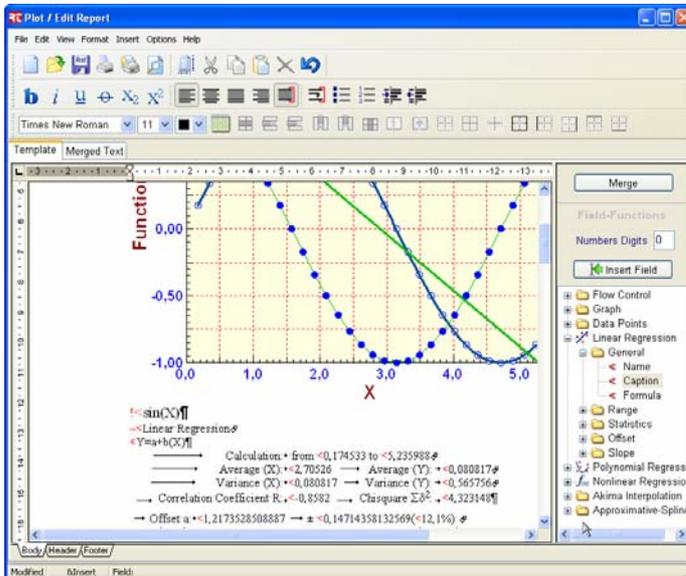
When the graph is zoomed, at the left and the bottom scrollbars will show the actually displayed range of values in relation to the total range of data available for display.

You can use the arrow buttons at the bars to scroll the axis tick wise. Clicking besides the sliders will scroll page wise, meaning one full range of the axis. The sliders can be used to position the view according to the position of the slider.

If you press the **Ctrl** key and the left mouse button synchronously and move the mouse, the whole graph will follow the movement keeping the mouse button pressed. Thus you can pan around the data range.

5

Editing Reports



You surely want to alter the page layout or modify some text within the printed reports.

Plot uses template documents to control the outfit and contents of a report. The template document is a text stored in rich text format which can be opened using the **File – Report** option of each *Graph Window*. The different *Graph Windows* can hold different templates, which means have different report layouts. Each graph memorizes the related report template text file.

The *Edit Report* window is organized as many other word processors are. The top line contains the menu bar, followed by 2 toolbars. The first contains the file and clipboard functions, the character properties and the paragraph properties. The second contains font properties, table functions and frame properties.

The tree-view at the right is specialized on inserting field functions (see chapter 5.3 on page 44). It is only visible when the template document is active.

Below the main part of the window contains the edit area with rulers at the top and left indicating paragraph and page dimensions and tab stop positions. The top of the edit contains two tabs labeled **Template** and **Merged Text**. The template will always be the source for the report. The report will be generated every time the **Merge** button is clicked.

The document has three major areas. The **Header** will appear on every top of each page, the **Footer** is printed on every bottom of the pages and the **Body**. This is the major part of the document taking the content of the single pages. Each part can be selected by the corresponding tabs at the bottom of the edit window.

5.1 Working with the Text

As described above, the window contains two different documents: the template and the merged report document. Thus you can use this to either modify the template for a different layout, or to do manual additions to a report.

Please note that the file and page setup operations always work on the currently selected document. This means you must always select the correct document tab before you want to do the required operation.

Plot uses editing options common to most other word processors available. You can type in text at any position you like, mark text with the mouse or cursor keys, alter font and paragraph properties, insert tables, alter border styles etc..

Table 7: Keys active in the text editor

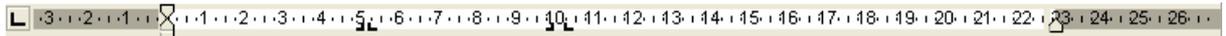
Key	Function
	Move caret one position left
	Move caret one position right
	Move caret one line up
	Move caret one line down
	Move caret to begin of word
	Move caret to begin of next word
	Move caret to begin of line
	Move caret to end of line
	Move caret one page up
	Move caret one page down
	Extend selection one position left
	Extend selection one position right
	Extend selection one line up
	Extend selection one line down
	Extend selection to begin of word
	Extend selection to begin of next word
	Extend selection to begin of line
	Extend selection to end of line
	Extend selection to begin of document
	Extend selection to end of document
	Delete character left to caret / delete selection
	Delete character at caret right / delete selection
	Switch insert/overwrite mode; caret changes accordingly
	Select all
	Undo last change
	Copy selection to clipboard
	Cut selection to clipboard
	Paste text from clipboard

The font properties for the current selection can be altered using the **Format – Font** option showing the Windows™ standard font dialogue. For a more interactive font style selection you can use the character style toolbar buttons: bold , italic , underline , strike out , subscript , superscript . The font can be chosen by the appropriate combo box in the second toolbar. The size of the characters can be set right to it. The color picker combo box, right beside sets the color of the text.

The paragraph properties as indentations alignment etc. can be set using the dialogue opened by **Format – Paragraph** or using the toolbar buttons:

Table 8: Paragraph formatting functions

Button	Function	Button	Function
	Align left		Keep together with next paragraph
	Align centred		Bullets list
	Block align to width		Numbered list
	Align right		Increase indentation
	Keep lines together (don't break on pages)		Reduce indentation



To assist you to set the paragraph properties interactively the top ruler is very helpful. The sliders at the left can be dragged to set the left border and the first line indent. The right border can be set by the slider at the right. The types of tab stops to set can be chosen at the left: left aligned , centre aligned , aligned at decimal separator  and right aligned . You can set a tab stop clicking to the appropriate position in the ruler. A stop is removed by clicking at it again.

You can create a table by defining the number of rows and columns after clicking the  create table button.

Table 9: Table functions

Button	Function	Button	Function
	Select row		Delete column
	Insert row		Select column
	Delete row		Split cell
	Insert column		Combine cells

The border styles of a paragraph selection or table range can be set using the **Format – Borders** dialogue or the appropriate speed buttons in the second toolbar.

Table 10: Borders formatting functions

Button	Function	Button	Function
	No borders		Left border
	Borders everywhere		Right border
	Inner borders		Top border
	Outer borders		Bottom border

5.2 Menu Functions

5.2.1 File Functions

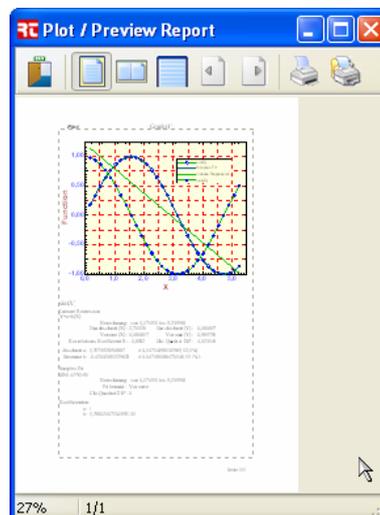
Please note that the file and page setup operations always work on the currently selected document. This means you must always select the correct document tab before you want to do the required operation.

The  **File – New** option will clear the current document and reset the page properties to their defaults.

The  **File – Open** and  **File – Save** functions will open a standard Windows™ file selection dialogue. There you can choose a filename to open from or to save the document to. If the current document is the template, the name will be memorized and be chosen for all the following report operations with the current graph.

Selecting the  **File – Print** option will print the current document on the printer selected. You can choose the printer and change its properties using the  **File – Printer Setup** function.

The  **File – Preview** option will open a small window showing how the document will look printed on paper. Within this window you can choose the view as full page, two pages and fit to width, select different pages to view and also set up the printer and print.



5.2.2 Clipboard Functions

As in the other windows of  **Plot** supports data transfer from program to program and text position to text position via the clipboard functions. This means if you have marked any text, this selection can be copied or cut into the clipboard and pasted to any program supporting clipboard functions. The functions are accessible via the **Edit menu – Cut – Copy – Paste** with the toolbar buttons    and the keyboard **Ctrl C**, **Ctrl X** and **Ctrl V**.

5.2.3 View Options

The **View** sub menu lets you set some of the display properties of the documents.

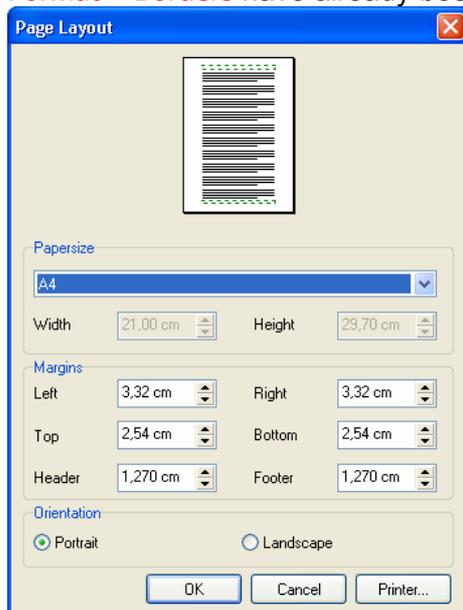
If the **View – Insert Points** menu function is checked, the red field insert point symbols are visible. This gives you a better overview to the template document when you want to edit merge fields (see chapter 5.3 on page 44).

If the **View – Paragraphs and Space Markers** option is selected the window will show special symbols for tab stops (→), space (·), linefeeds (↵) and paragraphs (¶). This might also assist you to do a better text formatting. The special symbols however will not be printed.

The size of the display of text can be altered using the **View – Zoom 100%**, **View – Zoom to Width** and **View – Zoom Page** options. The first will show the text in the same size as printed, the second will adjust the size that one line will fit the width of the window and the last will show a full page.

5.2.4 Formatting Options

The Format sub menu contains all the dialogues controlling the formats of characters, paragraphs, border frames and the whole page. The **Format – Font**, **Format – Paragraph**, and **Format – Borders** have already been mentioned previously (see chapter 5.1 on page 39).



The **Format – Page Setup** dialogue can be used to set the display option for the whole page. The top drawing always symbolizes the effect of the current settings. You can select the paper size from a drop down list or set a custom size in the **Width** and **Height** fields below.

The margins of the page can be set below giving the values of the distances for the **Left**, **Right**, **Top** and **Bottom** borders to the body text. The **Header** and **Footer** values give the distance to the page borders for the header and footer respectively. Thus they must be taken smaller than the **Top** and **Bottom** values to prevent interferences with the body text.

The print orientation can be set with the relevant radio buttons to **Portrait** and **Landscape**. This setting however can be done with the printer setup dialogue also reachable directly with the relevant button.

5.2.5 Inserting Images and Page Numbers

The **Insert** sub menu contains some functions to insert special items into the text.

Selecting the **Insert – Image** option will open a standard Windows™ file selection dialogue to select an image file (bmp, jpg, wmf or emf). This image will be included with the document at the current position of the caret. The size of the image can be altered by clicking to it and using the seizer frame grips to drag the frame to the desired new size.

The **Insert – Page Number** function will insert a page number field to the current position of the caret. The **Insert – Number of Pages** will insert a total page count field. These two options will display are always actualized value of the current page and the current page count. They are especially useful in footers.

5.3 Inserting Fields

This is the most complicated chapter within this document, because it deals with controlling the field variables in the template text, giving the merged report. But with the help of the supplied examples you might succeed in creating your own template documents.

With the installation procedure a sub directory in the **Plot** directory “\Templates” was created there you can find some example template documents: “Default.rtf” giving a report with portrait orientation and including the results of all calculations. “Landscape.rtf” will do the same report but with landscape orientation.

Please do not overwrite these example template documents with your own creations. It might happen that the changes you made do not give the results you once expected. Thus you might be happy to return to the well tested ones created by me.

If you activate the template document at the right side a tree-view panel gives access to the field functions.

All field functions are indicated by so called “insert points” these are special red characters indicating the position of the function. If you don’t see any insert points please check the **View – Insert Points** option. “<” indicates there has been inserted a result of a calculation. If the caret is inside a text generated by a field function, the corresponding control is activated inside the tree-view. Additionally the status bar at the bottom of the window shows a description of the field.

Insert Field: LinearRegression.AverageY display 8 digits

The tree-view is divided in several groups giving an ordered access to the manifold functions. These are indicated by the field mark “<” or special red control fields listed in **Table 11**.

A calculation result field can be inserted the following way:

Firstly select a group containing the desired function. This means choose the desired calculation, Flow Control, Graph or Data Points. Here you can select the appropriate field.

Secondly you can enter the number of digits you want to display with variables giving a numerical result, with the edit field “Numbers Digits”. Variables giving a string as result will ignore this parameter.

To insert the field into the template text either click the  -button or double click the field in the tree-view. Directly after selection, the new field is inserted showing the actual result with the specified digits.

You can delete a field as if you would delete any other “normal” text.

If the selected function does not correspond to a active calculation in the *Graph Window* it is impossible to display a calculation result. Instead a “@NotFound@” is displayed. This marker however is only visible in the template view. The merged text will have all lines erased containing calculations which are not active.

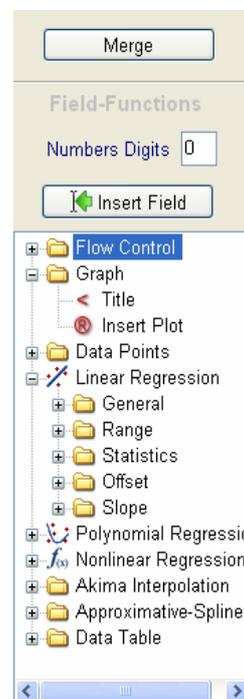


Table 11: Special field functions

Insert Key	List Item	Function
Ⓜ	Graph – Insert Plot	Insert current graph
1	Flow Control – List – Reset Index Counter	Begin of list of coefficients section /maxima/minima – reset index counter
+	Flow Control – List – Increment Index	End of coefficients section – increment index counter
#	Flow Control – List – Insert Index Number	Insert current coefficient index
~	Flow Control – Calculation – Start	Begin of calculation section
§	Flow Control – Calculation – Stop	End of calculation section
!	Flow Control – Series – Start	Begin of series section
&	Flow Control – Series – Stop	End of series section

To understand how the flow control fields work, you have to think which logical parts a report is combined of. At the top there will be some more general remarks including title and the plot itself. Following will be a list of all the results of all the data series. Thus it makes sense to structure the report text into chapters containing all the calculations related to one series. Additionally calculations can contain lists of calculation parameters as e.g. the coefficients of a polynomial or the list of the maxima of the interpolation. Thus we need a tree stage order of repeated parts of the text: Report – includes series – includes calculation – includes coefficients. During processing of the merged report  **Plot** will repeat the sections included inside the special marker fields as often as needed. Lines with empty fields will be deleted. Thus you need to enter only one item of each part included inside the special fields as brackets, to generate the whole report. If you look to the sample template text things will become clear.

For testing the current template you can click the  button. This will execute the merge process using the currently available calculations and results.

Appendix

A Modifying the User Settings

Within the installation procedure  **RtPlot** creates a new folder within the user's application settings directory of windows. This directory is normally a hidden directory. Depending on the Windows™ version and the language, this directory may have different names. You will surely find it easily if you have enabled the display of hidden directories within your windows explorer. It should have a name something like: "C:/Documents and Settings/Your Username/Application data". Within the subdirectory "/RtPlot" a file "RtPlot.usr" will store all user settings. You can open this file with any text editor e.g. WordPad. Please note that if you do any changes within the program settings file, that these changes may prevent the correct work of  **RtPlot**. Thus please keep a backup copy of the original file, to be able to restore a working copy. Some parameters you might want to change are listed with the following table.

Table 12: Program Parameters / User Settings

Section	Parameter	Description
[Table]	MaxColumns=26	Data columns A...Z. Setting to a higher value will show more columns e.g. AA...ZZ. Please note that calculation formula can only contain column variables A...Z (see chapter 3.1.1 on page 11)!
[CalculationConstants]	Any constant e.g.: cR=8.3143 ck=1.38062e-23	Physical constants used by the formula interpreter (see chapter on 3.1.1 page 11 and chapter 4.3.3 on page 31). Please add a prefix "c" to avoid confusion with column indicators or the dependant and independent variables.
[GraphScale]	RoundField= 0.1,0.25,0.5,0.5,0.5, 0.5,1,1,1,1 TickField= 0.02,0.05,0.1,0.1,0.1, 0.1,0.2,0.2,0.2,0.2 MajorTickField= 0.1,0.25,0.5,0.5,0.5, 0.5,1,1,1,1 LabelsField= 0.2,0.5,1,1,1,1,2,2,2,2	Values used by the auto ticks option for the axis (see chapter 4.2.2 on page 23). The fields contain comma separated arrays of the default values used for rounding the end values, the minor ticks, the major ticks and the scaling numbers depending on the normalized difference of start and stop value as index.

B Formula used for Linear Regression

All the linear regression calculations of  **Plot** use the following formula to calculate the results^[1].

Line: $Y=a+bX$		i : index	n : number of points
	Without statistical weights	With statistical weights (W_i)	
Mean:	$\bar{X} = \frac{\sum X_i}{n} \quad \bar{Y} = \frac{\sum Y_i}{n}$	$\bar{X} = \frac{\sum W_i X_i}{\sum W_i}$	$\bar{Y} = \frac{\sum W_i Y_i}{\sum W_i}$
	$Q_{XX} = \sum (X_i - \bar{X})^2$ $Q_{YY} = \sum (Y_i - \bar{Y})^2$	$Q_{XX} = \sum W_i (X_i - \bar{X})^2$	$Q_{YY} = \sum W_i (Y_i - \bar{Y})^2$
Variance:	$\sigma_X^2 = \frac{Q_{XX}}{n-1} \quad \sigma_Y^2 = \frac{Q_{YY}}{n-1}$	$\sigma_X^2 = \frac{Q_{XX}}{\sum W_i - 1}$	$\sigma_Y^2 = \frac{Q_{YY}}{\sum W_i - 1}$
Slope:	$b = \frac{\sum (X_i - \bar{X}) Y_i}{Q_{XX}}$	$b = \frac{\sum W_i (X_i - \bar{X}) Y_i}{Q_{XX}}$	
Offset:	$a = \bar{Y} - b\bar{X}$		
Residuals:	$\delta_i = Y_i - bX_i - a$		
Error of slope:	$\sigma_b = \sqrt{\frac{\sum \delta_i^2}{Q_{XX}(n-2)}}$	$\sigma_b = \sqrt{\frac{\sum W_i \delta_i^2}{Q_{XX}(\sum W_i - 2)}}$	
Error of offset:	$\sigma_a = \left(\frac{1}{n} + \frac{\bar{X}^2}{Q_{XX}} \right) \frac{\sum \delta_i^2}{n-2}$	$\sigma_a = \left(\frac{1}{\sum W_i} + \frac{\bar{X}^2}{Q_{XX}} \right) \frac{\sum W_i \delta_i^2}{\sum W_i - 2}$	
Correlation Coefficient:	$R = \frac{b\sigma_X}{\sigma_Y}$		

With fixed offset		
	Without statistical weights	With statistical weights (W_i)
Slope:	$b = \frac{\sum X_i (Y_i - a)}{\sum X_i^2}$	$b = \frac{\sum W_i X_i (Y_i - a)}{\sum W_i X_i^2}$
Error of slope	$\sigma_b = \sqrt{\frac{\sum \delta_i^2}{\sum X_i^2 (n-1)}}$	$\sigma_b = \sqrt{\frac{\sum W_i \delta_i^2}{\sum W_i X_i^2 (\sum W_i - 1)}}$

¹ P. Bewington, data Reduction and Error Analysis, Mc Graw-Hill, New York (1984)
G.L. Squires, Messergebnisse und ihre Auswertung, de Gruyter, Berlin (1971)



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