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## Introduction

### About Stem

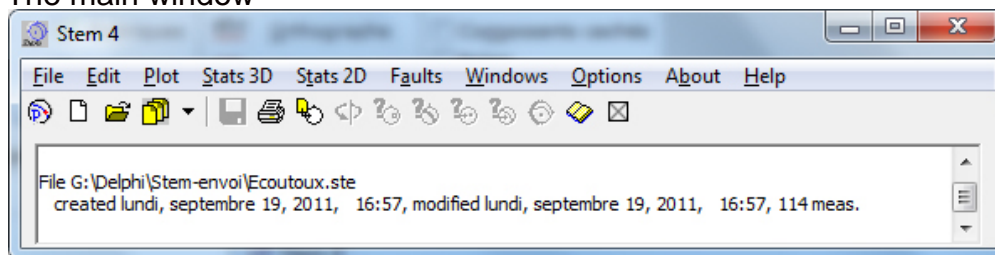
Stem1 is a freeware program which provides effective tools to handle structural data.

The present version is a largely updated version, not yet fully completed (some functions not yet re-implemented).

As compared to previous versions, main modifications are :

- An improved handling of the plot windows
- Improved importation of data listed in a text file
- Improved basic geometrical constructions
- Improved contouring
- Special facilities for fault databases and striated fault planes analysis
- Improved statistical tests
- Best fits in one window can be selected and displayed in the other windows

### The main window

















### The menus

- **File**, to set the database, using Stem datasheets
- **Edit**, the usual copy, paste and undo functions
- **Plot**, to display the data in a Wulff or Schmidt projection, and solve some simple geometrical problems
- **Stats 3D**, mainly to find best axis, best planes, best great circle or best small circle for a set of values
- **Stats 2D**, representation and statistics on 2D orientations
- **Faults**, a set of specific functions dealing with striated fault planes
- **Windows** to manage windows display
- **Options**, to fix the default settings


### The Stem tool bar

It provides short cuts towards the most often used functions, viz. :

-  L-S utilities
-  New datasheet
-  Open a datasheet
-  Reopen a datasheet
-  Save a datasheet or a plot
-  Enter data from a datasheet to built a canvas
-  Rotate the data
-  Identify a clicked pole
-  Identify a clicked cyclographic trace
-  Calculate a best axis
-  Calculate a best great circle
-  Show/Hide the calculated **extra values** (best fits...)
-  Erase the content of the Edition zone in the main Stem window
-  Display **Help**

The right button of the mouse also provides some shortcuts and a straight access to specific menus.

### Hidden functions (shift key)

 The **shift key** modifies or complements some functions. When convenient, a notification icon (green triangle) is displayed in the top-left corner of the plot window

### The datasheets and plot windows

Stem use two type of windows : **datasheet** windows to edit the measurements (the data), and **plot** windows to draws the canavs (Schmidt or Wulff projections, in upper or lower hemisphere) and other drawings. It is possible to have up to 16 datasheet or up to 16 plots simultaneously displayed. Each window can have its own "style" (for instance, different data formats in different datasheets, or mixing of Wulff and Schmidt canvas in different plots).

## Menu File

### Managing the orientation data







Stem use specific data files (.ste files) to store the data. A special type of window, a [datasheet](#), is designed to easily enter new data, using a specific edit field (lower part of the window), or to display/modify an already existing .ste file. Stem can also import data stored in a text file (.txt, .dat), converting the file into a Stem file.

Each data (i.e. a structural measurement, either a plane or an axis) can have up to 4 codes attached to it, to specify the nature of the measurement, to give it a number, ...Only the "nature" code is compulsory, as its first character is used to identify planes and axis when plotting the data in a canvas.

Several display formats ("styles") are available. You can modify at any time the display format of the data, by clicking in the table with the right button of the mouse.

It is possible to have up to 16 datasheet simultaneously displayed, and each datasheet can have its own "style" (for instance, different data formats, or different integer/decimal option). You can modify the order of the columns or the order of the rows of the table (using the mouse to drag the rows or the columns to your convenience). You can sort the data on any column (item Sort, in sub-menu [Data utilities](#)) .

### Items of the File menu

-  New
-  Open
-  Reopen
- Import data
- Datasheet utilities...
-  Line-plane value
-  Save
- Save as
- Export
- Delete
- Page set up
-  Print
- Quit

## New

To create a new empty table of values.

Maximum size of the table: as indicated in the About window.

In this version up to 5000 data in a datasheet or in a canvas; can be more on request.

Two parts in the [datasheet](#) window: an table to display the data, an edit zone to enter or modify the data. Several [data formats](#) are provided: click with the right button of the mouse in the table to select your preference, or go to the [options](#) menu.

Codes are used to differentiate the various types of data. They are the codes which allow later on discrimination of the data. Each code is an alpha-numeric string of up to 9 characters. The code "number" can be used either as a number, or as an alpha-numeric world, and can be sorted either by number values or by world order. To change the names of the codes, go to the [options](#) menu



**The code "nature" is compulsory**, as its first character is used to separate lines from planes. First character can be 'F', 'P' or 'S' for a plane, and 'L', 'A' or 'B' for a line. Upper or lower case are allowed, and are seen as distinct characters in data selection processes. All the other codes can be left empty.

## Open

### Opening a Stem data file and displaying its content in a datasheet

#### Stem files and datasheet

Data are stored in specific Stem files. In a Stem file, a measurement (a line or a plane) is stored as 2 angles (in radians) : azimuth  $[0 .. 2 \pi]$  and plunge  $[0 .. \pi/2]$ . To be processed, data are displayed and edited in a datasheet (angles in  $d^\circ$ , integer or decimal value), in a format depending of your choice. When you [save](#) the file, the modified or new data of the datasheet are copied back to the Stem file.

#### Integer and decimal values

You can choose to display measurements using either decimal (only 1 digit for the decimal part) or integer numbers. To shift from decimal to integer, use the "[decimal](#)" button in the edit zone.

The way of displaying a file doesn't modify the values actually kept in the Stem file, neither the table of data lying in background of the datasheet. But if you make some changes in a datasheet, then save the modified datasheet, all the lines which have been modified (and only those ones) will be rewritten in the Stem file.



Accordingly, consider a datasheet in which a line has been modified (for instance, a line in which you have changed something in one of the codes, but not the measurement itself) : if the measurement was initially a decimal value (i.e. was having an accuracy of  $0.1d^\circ$ ), but is now displayed as an integer value in the datasheet (i.e. rounded to the nearest  $d^\circ$ ), it is the rounded value (converted in radians) will be written and kept in the modified Stem file, instead of the more acute initial value.

## Reopen

### Reopen

To reopen one of the last displayed files.

The most recently opened file is the uppermost one in the list

## Import data

To convert a text file into a Stem file

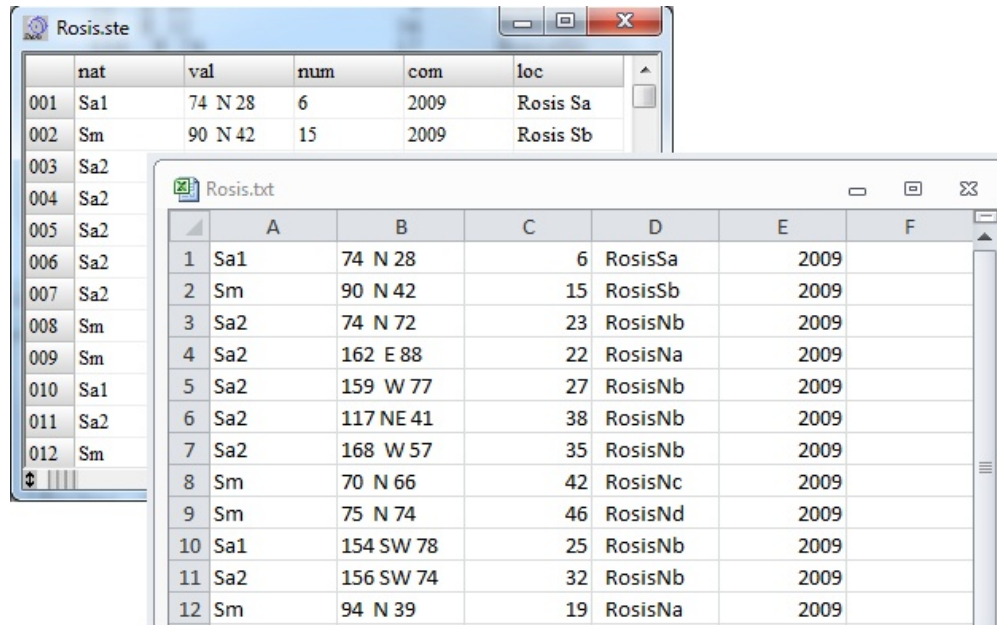
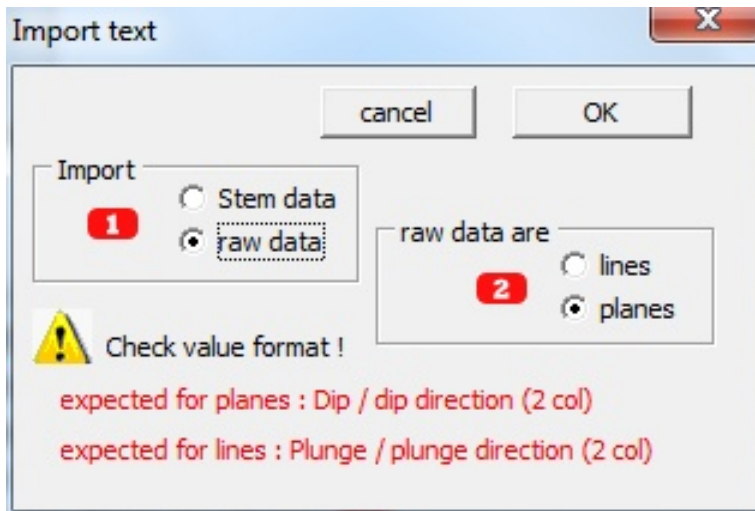


Fig. 1 Importation of a text file

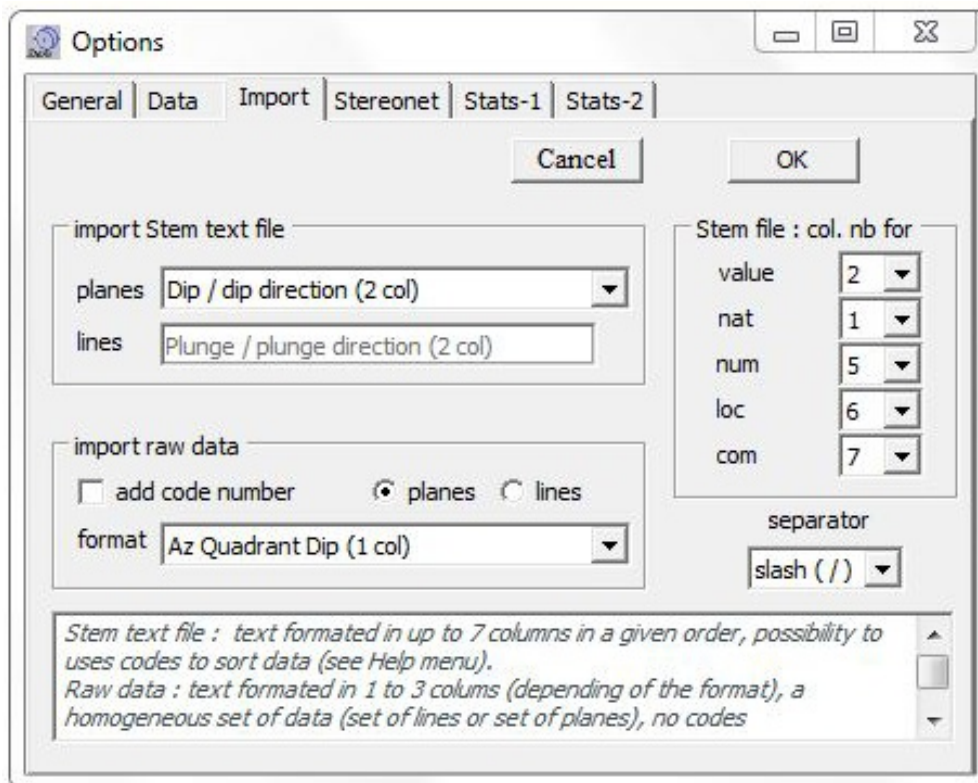
An example of Excel spreadsheet (with several columns, mimetic of the Stem file), and the Stem file as it appears after importation.

Data can be stored in a text file (extension .txt), can be issued from any word processor or spreadsheet (e.g. above). It can be unformatted (a list of homogeneous measurements, either axis or planes), or formatted following the Stem file conventions (i.e. one or several codes used to discriminate the data attached to each data). In both cases, one data must correspond to one line of the file. A line can have any number of spaces, but spaces cannot be used as a separator to bound the different fields of the line.

Select in the dialog the type of data to import, either raw data or Stem-like data **1**. If it is only a list of measurements (raw data), don't forget to specify if data are lines or planes **2**. The current expected format is given at the bottom of the dialog.



If the file contains Stem-like data (with codes to discriminate the measurements), a line of the file can have several fields. Stem must know the number of fields, in which order they are (order of the given codes and format for the measurements), which is the separator between the fields (it can be a tab, a slash or a dash). It can be checked and modified using the [Options dialog](#), sheet " Import".



When importing Stem-like data, the file can mix lines and planes values. Lines and planes must share the same format. Accordingly, in the Options dialog, you fix only the format used for a plane; the paired format to use for a line is then mandatory; it is given in the disabled "lines" box of the dialog.

When importing Stem-like data, don't forget to give the position (column number) of the different



codes. A line of the file can have empty fields. Only the code "nature" is mandatory, as used to distinguish lines and planes.

The measurement itself can be stored in 1, 2 or 3 columns, depending of the choice of its format (in the given example, 2 columns). The "column number" for the "value" field is the index of the first column.



A text file created from Stem using the [Export](#) function starts by 4 heading-lines, which give the file name, the formats uses for planes and axis, the columns order. If you want to re-import the file, don't forget to delete these 4 heading-lines in the text file.

## Datasheet utilities

A set of functions to manage the datasheet

## Find

A dialog to find a given data in a data sheet

Searching is done in the column corresponding to the selected code, either in the top-bottom or bottom-top sense . You can also search on the value itself (f.i. to find all the data which azimuths are comprised between v1 and v2 values).

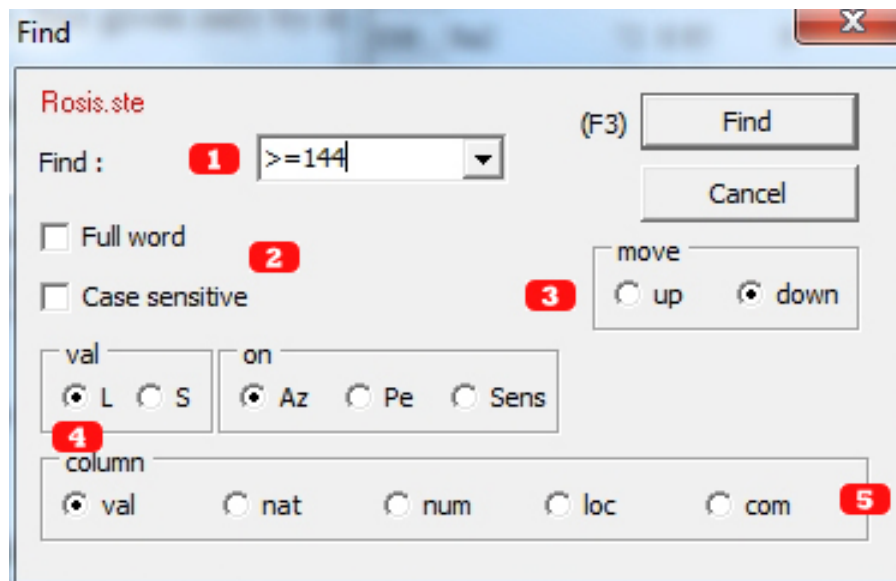


Fig. 2 dialog Find

Searching on the value

The "val" radio button (4) (in the "column" box (5)) let you find measurements for which azimuth or dip is equal to a value, or bracketted in a range of values. Check the line (L) or surface (S) radio-button, and the azimuth (Az) or dip/plunge (Pe) radio-button, to fix your search. Enter in the box (1) the range of values, using the following operators

- = (identity)
- >, >= (greater, greater or equal to)
- <, <= (smaller, smaller or equal to)
- a-b (value in the interval a to b, a and b included)

Searching on a code

Select one of the other columns (i.e. one of the codes accompanying each data) in the "column" box (5) . Select the data to search using the drop-down list (1), or type your selection in the box.

## Change

A dialog to change a data or a set of data in a datasheet

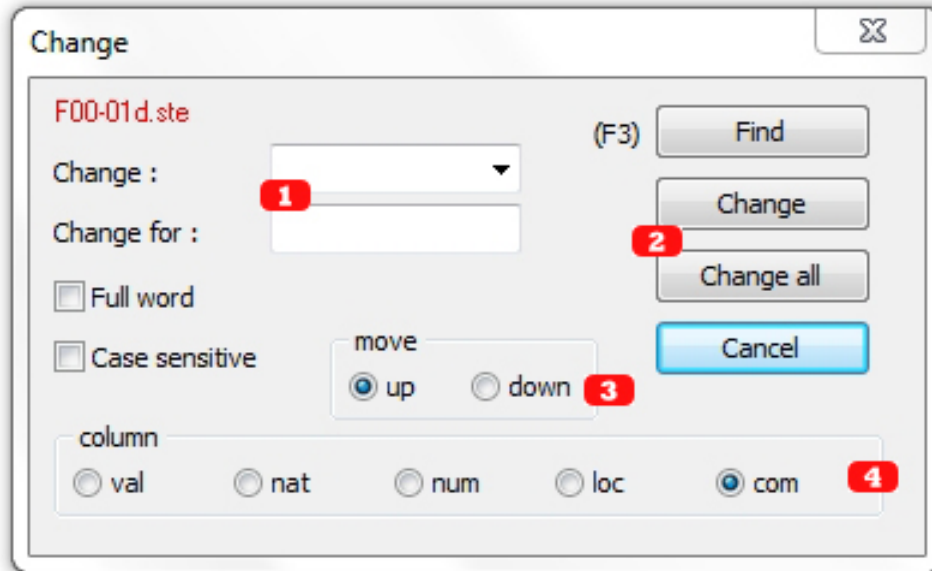


Fig. 3 dialog Change

Select the data to modify using the drop-down list **1**. You can change the data one by one, or change all the data sharing a same code (buttons Change or Change all **2**).

Searching of the data to change is done in the column corresponding to the selected code **4**, either in the top-bottom or bottom-top sense **5**.

## Round data

### Rounding of values initially given as decimal values

In specific Stem files, data are stored as 2 angles in radians :

- for an axis, the trend (azimuth) and plunge,
- for a plane, the trend (azimuth) and plunge of the normal to the plane.

Display in a datasheet : integer v. decimal values

When entering data in a datasheet, the angles are given in  $d^\circ$ , either as an integer value or as a decimal value (with one decimal digit, i.e. an accuracy of  $0.1^\circ$ ). When saving the datasheet, the value given in the datasheet is converted to radians and stored in a Stem file.

When you **reopen** a file, you can choose to display the measurements either as integer or decimal values : you can shift from integer to decimal format using the "integer/decimal" button of the datasheet. Accordingly, angles values in the table are given either rounded to the nearest degree value, or with 1 decimal digit. *The change in the way of displaying the data doesn't affect the values actually kept in the file.*

### Rounding the data

When using the "round data" function, *it is the value actually stored in the data file which is modified* .

If the value was originally given with  $0.1^\circ$  accuracy, the initial accuracy is lost.

## Select

A dialog to select in a datasheet a subset of data fitting with a given search criteria  
The selected data are displayed in a new datasheet.

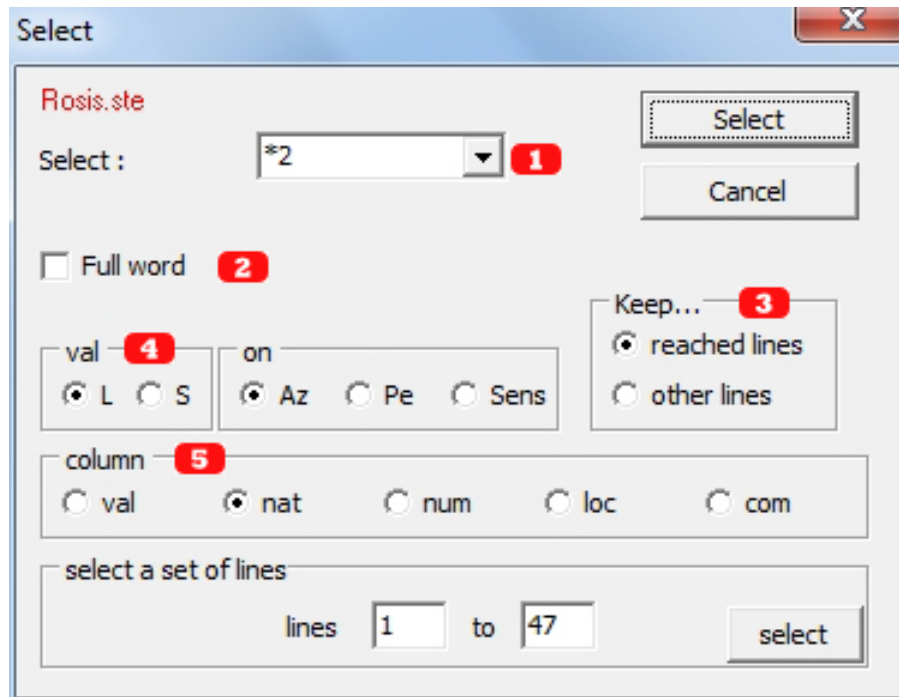


Fig. 4 dialog Select

Button "keep" **3**: you can keep all the lines fitting with the search criteria (positive choice), or keep all the lines but those ones (negative choice).

Selection is done on one specific code (one specific column) of the datasheet **5**. To facilitate the selection, the list of codes actually in the selected column is displayed in the dropdown-list **1**. You can also directly type your selection in the box.

If you don't check the "Full word" check-box **2**, you can select data with only partial equivalence between the actual code value (in the datasheet) and your selection key (in the box). F.i., if the column selected is "nat" and your selection key is "S", all the data with "nat" code starting by "S" will be kept. You can also use "\*" as a joker: the equivalent part of the code will be forgot in the selection process (f.i. if you give "\*2" in a data sheet where some data have the code "L2" and some the code "S2", both sets of data are kept in the selection).

Selection on the column "value" (on the measurement itself)

You can select the measurements which azimuth or dip is equal to a value, or within a range of values. Check the line (L) or surface (S) radio-button, and the azimuth (Az) or dip/plunge (Pe) radio-button, to fix your search. Enter in the select box the range of values, using the following operators :

- = (identity)

- $>$ ,  $\geq$  (greater, greater or equal)
- $<$ ,  $\leq$  (lower, lower or equal)
- $a-b$  (interval  $a$  to  $b$ ,  $a$  and  $b$  included)

## Sort

### Sorting the data

To sort the data using one of the codes, in ascending or descending order.

Code "number" (often used to keep an outcrop reference number) is specific : actually it is not a number, but a word (string of characters), as the other codes.

Nevertheless, it can be sorted as a number as well as an alphanumeric string : for instance, if the codes are 1, 2, 3,...19, 20, 21..., sorting using the "numbers as string" function will give the following result : 1, 10, 11...19, 2, 20, 21, ...



## Info files

### Info files

Information on the data files displayed in the opened datasheets :directory, date of creation, date of last modification, number of measurements

## Info codes

### Info codes

List of the codes used in the opened datasheets

## Merge files

To merge together several datasheets

To merge in a single datasheet the data of all the opened datasheets. The order of the data in the new datasheet (bulk set of values) follows the order of the merged data sheet (first data in the list : data of the uppermost datasheet)

## Open other files

To open any other files than Stem files

To display in a new window any type of file, whatever its extension. Of course, this is meaningless if the file is not a text file (".txt" file, or assimilated to, f.i. a ".dat" file) or a rich text file (".rtf"). You will mainly use this fonction to display :

- standard text files (extension .txt)
- rich text files (extension .rtf)
- Stem text files (extension .txt)
- faults-processor data bases, f.i. Stress (extension .dat), Yamaji mim4 (extension .fdt), TektonicsVB (extension .cor)

## Line-plane value

A tool which provides some simple geometrical facilities

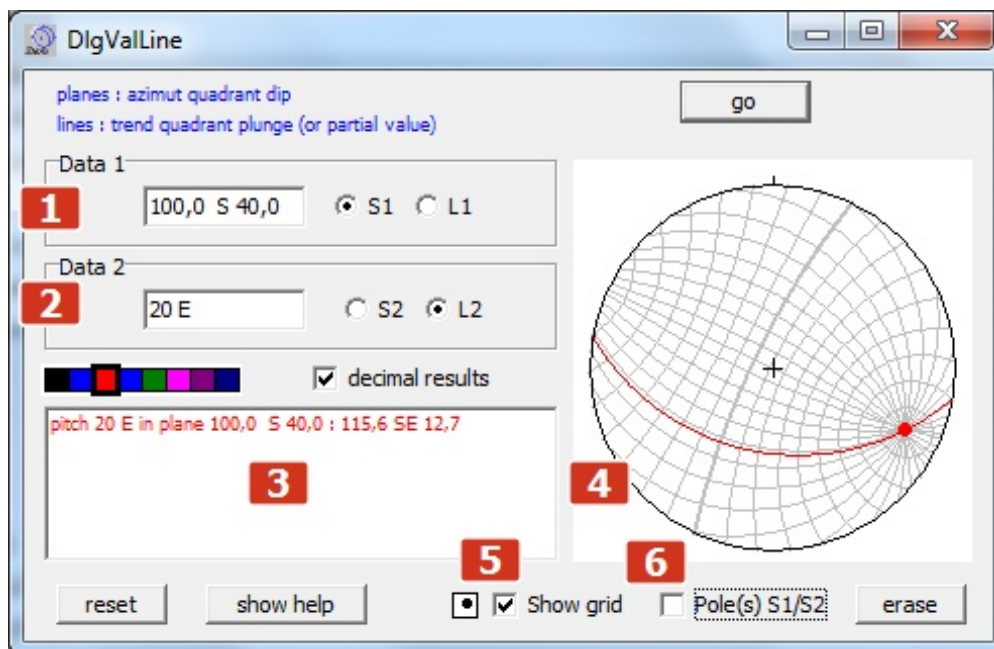


Fig. 5 the line/plane utility

1. value 1, here a plane S1
2. value 2 (a line L2 belonging to S1 and given by its pitch)
3. result : the orientation (azimut, quadrant, plunge) of the line
4. S1 and L2 projected (stereographic projection). Wulff net axed on L2
5. choice of the net
6. to plot also the pole of S1





A tool designed to solve some very common problems:

- Complete orientation of a line belonging to a given plane (f.i. a striae on a fault plane), when the line is known only either by its pitch (given exemple), its direction or its plunge
- [Intersection of 2 planes](#)
- [Plane defined by two lines](#)

**Button "go"** : to start calculation. If data 1 and data 2 are

- 2 planes (i.e. "S" selected for both data) : orientation of the intersection of S1 and S2 (a line)
- 2 lines (i.e. "L" selected for both data) : orientation the plane defined by L1 and L2
- 1 plane and 1 line : angle between the plane and the line.
- 1 plane and 1 line, line given only by its pitch, plunge or direction : line full orientation.

**Results** are listed, and projected in a Wulff canvas. When the "Show grid" check box is selected, a background stereographic grid is displayed. It can be (click on the icon to change the grid) a :

-  stereographic net
-  polar net
-  Wulff net centered on the calculated line (as in given example)
-  Wulff net centered on the horizontal of the plane

**Button "erase"** : erase results and canvas (to erase only the canvas, click in it)

**Button "reset"** : erase results, canvas and data.

**Format** to use for the data : same as currently selected for datasheets

**Formats to use for a line** (if only a partial orientation is given) :

- pitch and pitch quadrant (N, S, E, W) (f.i. 20E or E20)
- strike of the line (f.i. 122 or 302)
- "?" + plunge, or "?" + plunge + plunge quadrant (f.i. : ?25, ?N25)

## Save

Saving a datasheet or a plot

To save the active window content to a file.

The action differs depending of the nature of the active window (data sheet, text or canvas)

Data sheet

**Saving towards a Stem data file (file \*.ste)**

Any text file

**Saving towards a text file (file \*.txt)**

Canvas or another type of plot (f.i. a rose diagram)

**Saving towards a graphic metafile (extension .emf). It is the Window format to save vectorial drawing. \*.emf files can be open in almost all the vectorial drawing softs (f.i. Adobe Illustrator, Canvas, Inkscape).**

**A dialog allows the choice of the diameter of the saved canvas.**

**The "extra values" (f.i. calculated best fits) which are actually in the canvas (and only those ones) will be saved too. Before saving, you can add or delete all or part of them using the [Display best fits values](#) function.**



*The Save canvas function is not equivalent to the Copy function. While the Save output is a vectorial file, which can be modified or improved in a drawing soft, the Copy function makes a raster (bit map) copy. It can be pasted in any document (f.i. a Word file or an Excel™ table), but hardly modified*


## Save as

Save a datasheet under a new name, or saving in a datasheet the plotted data  
The action differs depending of the active window (text window, data sheet or canvas)

### Data sheet or Text window

Saving towards a Stem file (\*.ste) or a Text file (\*.txt)

### Canvas

Creation of a new datasheet, listing all the measurement actually in the canvas (the canvas can includes data coming from different data sheets). Alternatively, you can use the "Save to datasheet" button (  ) in the Plot window tool-bar.



If the active window is a Plot window, don't mistake :

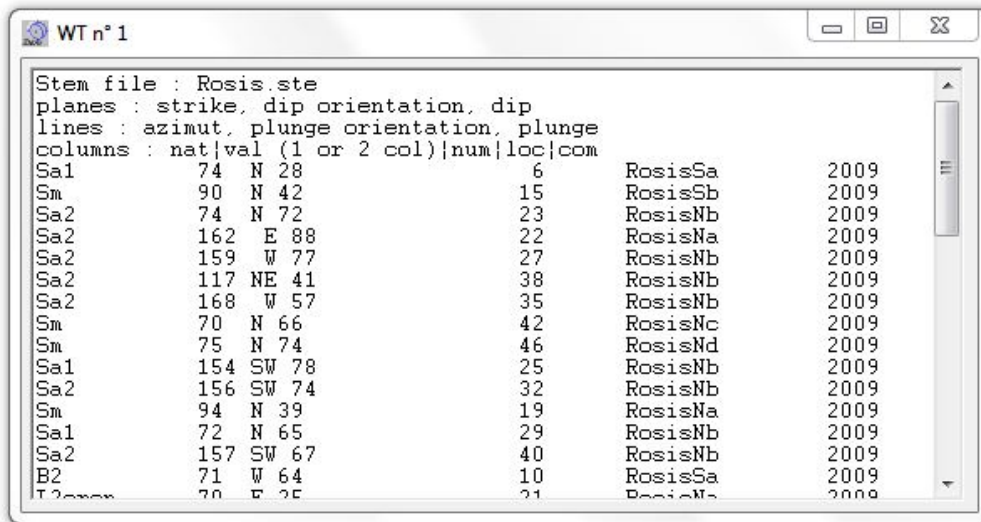
- Save : save the canvas itself (a vectorial graphic file),
- Copy : copy the plot picture (a bit-map),
- Save as : saves the measurements displayed in the canvas (a datasheet).



## Export

To export a datasheet as a text file

Useful to exchange data with another program (for instance a striated fault planes processor), or to modify a file of data using a word processor or a spreadsheet. The datasheet is displayed as a text file in a new window. Save the text using the [Save](#) or the [Save as](#) command.



```

Stem file : Rosis.ste
planes : strike, dip orientation, dip
lines : azimuth, plunge orientation, plunge
columns : nat|val (1 or 2 col)|num|loc|com
Sa1      74  N 28          6      RosisSa      2009
Sm       90  N 42         15      RosisSb      2009
Sa2      74  N 72         23      RosisNb      2009
Sa2     162  E 88         22      RosisNa      2009
Sa2     159  W 77         27      RosisNb      2009
Sa2     117 NE 41         38      RosisNb      2009
Sa2     168  W 57         35      RosisNb      2009
Sm       70  N 66         42      RosisNc      2009
Sm       75  N 74         46      RosisNd      2009
Sa1     154 SW 78         25      RosisNb      2009
Sa2     156 SW 74         32      RosisNb      2009
Sm       94  N 39         19      RosisNa      2009
Sa1      72  N 65         29      RosisNb      2009
Sa2     157 SW 67         40      RosisNb      2009
B2       71  W 64         10      RosisSa      2009
T2       70  E 25         21      RosisNa      2009
  
```

Fig. 6 Stem file to a text file

The file starts by 4 heading lines giving the name of the Stem file, the format for planes, the formats for axis, the columns sequence. If you want to re-[import](#) such a text file, don't forget to delete those 4 lines.

### Exporting faults datasheets

Stem provides a tool for easy building of a datasheet containing only striated planes + striae measurements ([Faults/striae datasheet](#)). The data can be exported to a text file, in the specific formats requested in entry by some faults processors : 'Stress 331' (Th. Villemin), Tektonics VB or Yamaji Mim4. Use the Export faults datasheet function, instead of the standard Export function.

## Delete

### Deleting a file

A function to delete either the file displayed in the uppermost datasheet (if any datasheet displayed), or a file selected via the standard “ open file” dialog (if no datasheet is displayed).

## Page set up

Standard dialog to set up the printer

## Print

### Printing the active window

The active window is the uppermost window, either a datasheet or a plot.

Printing can be a standard output on an external printer, but you can also use the Print function to save the window as a \*.pdf document, using a pdf printer (f.i. the PDFcreator).

### A datasheet

Printing of the table of values.

Using the [options menu](#), you can choose either to print the grid lines (41 measurements per standard A4 sheet) or not (46 measurements per standard A4 sheet).

\*.pdf output : each page of the list corresponds to 1 pdf file

### A plot window

Printing of a canvas or a diagram.

A dialog let you choose the size of the printed canvas (diameter in millimeters). Center of the canvas is fixed to the half width of the paper sheet. Top of the canvas is 2 cm down the top of the paper sheet.

The [aditionnal values](#) which are actually in the canvas (and only those ones) will be printed too.

Before printing, you can modify them (add or delete all or part of them) using the [Display best fits](#) function.

It is sometimes more convenient to save the canvas as an .emf file (vectorial drawing file) ([Save function](#)), and then to print it from a drawing software, rather than directly from Stem. If so, uses the "Ungroup" command of the drawing soft to access to the different elements of the drawing.

### A text window

Standard printing.

## Quit

Quitting

Safe quitting of Stem

## Menu Edit

Editing text or drawing



Undo, Cut, Copy, Paste : edit functions always implies the active window or the selected text, and the last action in this window

- Undo
- Cut
- Copy
- Paste

## Undo

To undo the last entry, in a datasheet or in a plot.

To undo the last command in a plot

## Cut

To cut a part of a text

Only applies to editable text field



## Copy

### Copying (Ctrl C) from one document to another one

Note : as all Edit functions, Copy relates to the active window or the active selected text

#### Copying a plot

When copying a canvas or a diagram using the Copy function, your copy is a raster picture (a bitmap), i.e. a set of pixels, as it is on your computer screen. Accordingly, when you will paste it, the pasted picture will be also displayed as a set of pixels, and can have a rather rough aspect. Some softs (f.i. Word™, Illustrator™) accept straight pasting of vectorial files (actually the Window™native .emf format), and the picture is then of much better quality, whatever the enlargement of the document. To do this in Stem, use the [Save canvas](#) function to make a .emf file, select the newly created file, Ctrl C to copy it, then Ctrl V to paste it in your document.

## Paste

### Pasting from one document to another one

Note : as all Edit functions, Paste is relative to the active selected text

### Copying and pasting text

To copy and paste text from one document to another document, or in Stem from an edition field to another edition field.

### Copying and pasting drawing

When copying a picture using the Copy function, your copy is a rasterized picture (a bitmap), i.e. a set of colored pixels, as it is on your computer screen. Accordingly, when pasting it in a document, the pasted picture will be a bitmap with the same dot/inch definition, and could have a rather rough aspect. Some softs (f.i. Word™, Illustrator™) accept straight pasting of vectorial files (actually the Windows™ native .emf format), and the picture is then of much better quality, whatever the enlargement of the document. To do this in Stem, use the [Save canvas](#) function to make a ".emf" file. Then, select the icon of the newly created file (click on it), "Ctrl C" to copy it, then paste it in your document.

## Menu Plot


### Plotting the data in a canvas

A special type of window, a [plot window](#), is designed to plot your data in a canvas (Wulff net or Schmidt net, projection in the upper or lower hemisphere).

It is possible to have up to 16 canvas simultaneously displayed (i.e. up to 16 windows), and each canvas can have its own "style" (for instance, a set of data can be displayed in a Schmidt net, while the same set or another set will be displayed in another window in a Wulff net). To change the style of a canvas, click in the canvas with the right mouse button.

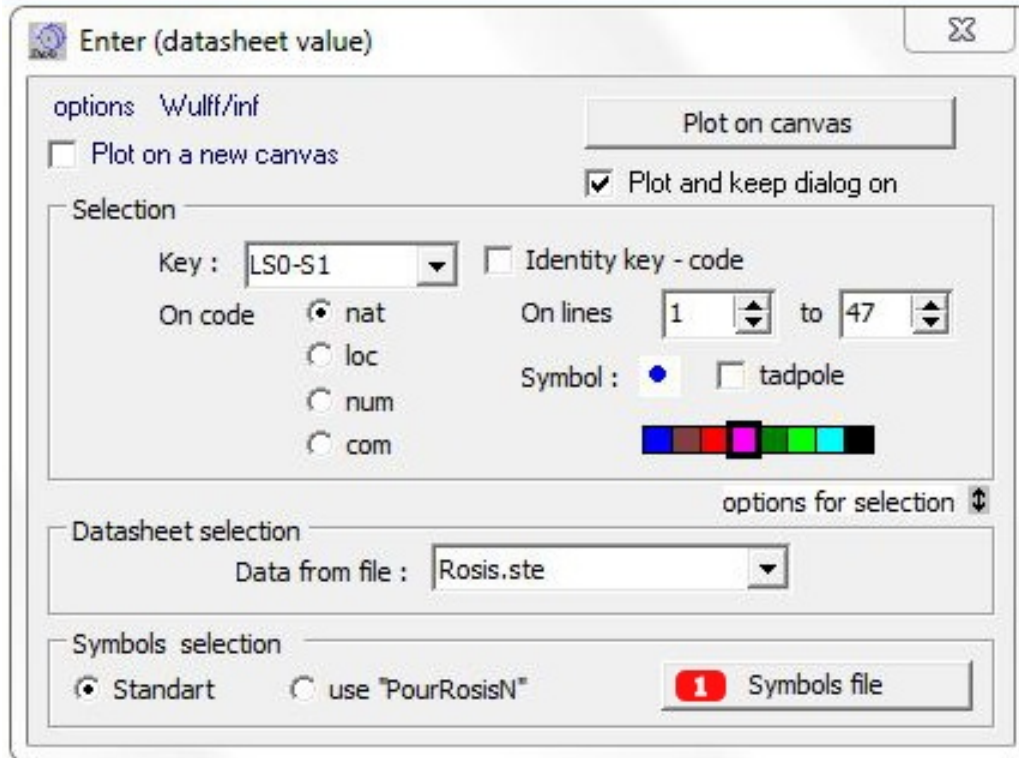
Active window: the uppermost window. All the calculations deal with the data plotted in this window.

- [Enter \(datasheet\)](#)
- [Enter \(key in\)](#)
- [Enter \(clicking in canvas\)](#)
- [Identify](#)
- [Modify](#)
- [Rotation](#)
- [Other graphical utilities](#)
- [Display net](#)
- [Erase net](#)
- [Clean](#)

At any time, you can save the data plotted in the canvas in a datasheet, clicking in the "transfer to datasheet" button () below the canvas

## Enter (datasheet)

Displaying data from a datasheet in a new canvas



You can plot the selected data either in the front (active) canvas (if there are already several canvas displayed), or in a new canvas (i.e. in a new window). Each canvas can have its own style.

To select specific data amongst the whole set of data listed in the datasheet, use the "key" box. You can make your selection on only a subset of data (from line X to line Y), or on the whole set of data. Your selection can be :

- empty : all the data of the datasheet (or of the datasheet subset) are reported,
- a specific code in the list displayed in the drop-down list of the "Key" box,
- or you can type your selection in the box.

In the last case, selection can be:

- the code itself (e.g. 'Lm', 'Lm1', 'Lm2', 'LX2', 'LB1', 'Sm1')
- all the codes starting by the same character(s) (f.i. 'Lm' will select as well 'Lm' than 'Lm1' and 'Lm2'). If you want to restrict your choice to only 'Lm' (i.e. you don't want to plot also the data identified by 'Lm1' or 'Lm2'), either tick the box "identity key-code", or add a slash after the word ('Lm/').
- a set of codes differing only by few characters : a joker (\*) allows you to ignore some characters

of the code. For instance, 'L\*2' will select as well 'Lm2' as 'LX2', or '\*\*1' will select both 'LX1' and 'Sm1'.

#### Choice of symbols

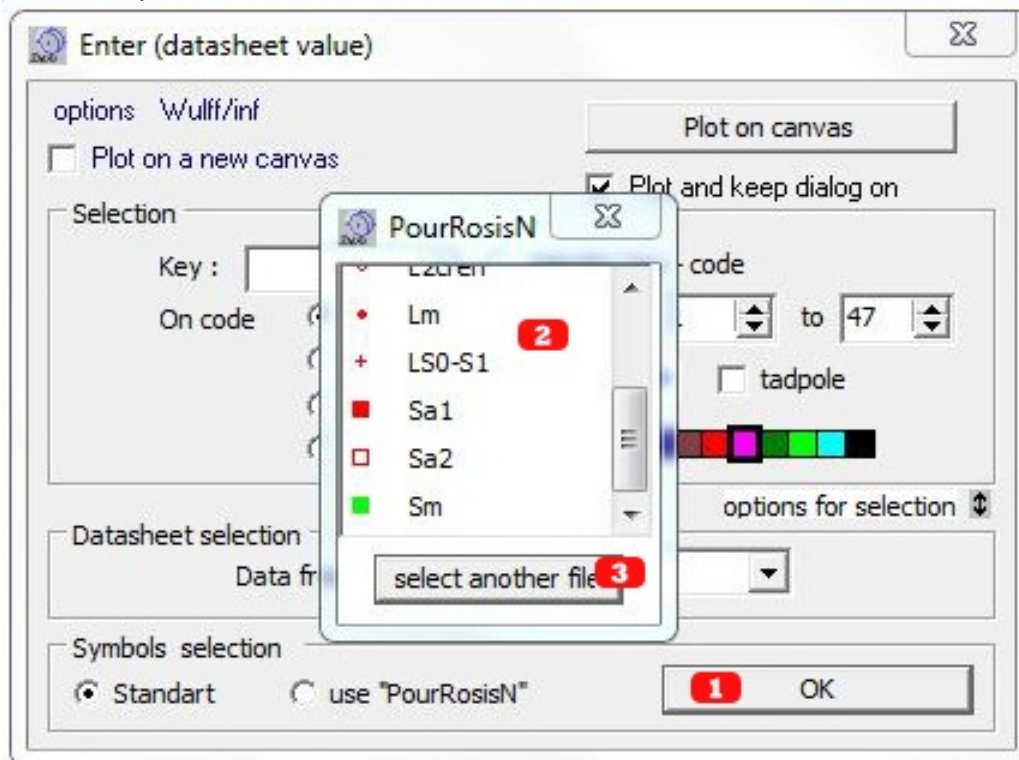
A set of 16 symbols and 8 colours is available. The defaults colors can be changed (menu "Options").

Several ways to choose your symbols :

- Standard : select a symbol in the "symbol" menu, and a colour in the colour bar. "tadpole": tadpole like symbols, with a tail pointing in the heading direction.

- From a "symbols file" **1**. Usefull if you want to keep the same symbol for the same type of data.

To set the symbols file



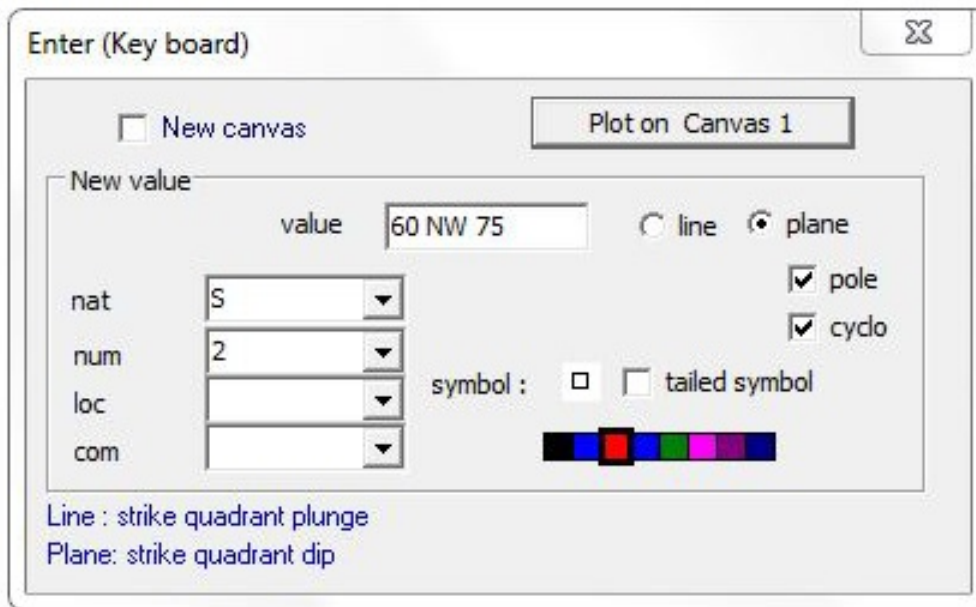
- To create a new symbols file, menu [Options](#), item "Choose", page "General"
- It is also possible to create a new symbols file from the symbols already used in the active canvas : double-click in the canvas, the list of symbols is displayed; click on the "Save" button to give it a name.
- To display or change the active symbol file (if any), click in the "Symbols file" button (its caption is then changed to 'OK' **1**), the list of symbols is displayed **2**, you can select another file **3** (click OK to confirm your choice).

All the modifications and calculations always deal with the active canvas (the upper most Plot window)

## Enter (key in)

To plot values typed one by one

Note - Once individual data plotted in a canvas, it is possible to keep them in a new datasheet, via the "Save measurements" function, or via the "transfer to datasheet" button (📄), below the canvas.



### New canvas

To plot the new data either on the front (active) canvas, or on a new canvas

### Line or plane ?

You can either give a code "nature" starting by one of the reserved characters use by Stem to know if the data is a plane (S, P or F) or a line (L, B, or A) (upper or lower-case), or check the convenient radio button line/plane. The code nature is not compulsory; if not specified, a defect "S" or "L" value will be given, according to which radiobutton is checked on.

### Symbol and color

Select one of the available symbols (16 possible symbols, displayed in a pop-up menu when you click on the symbol icon) and its color. For a plane, say if you want both cyclographic and polar display, or only one of those.

### Data format

The current data format for planes and lines is given at the base of the window. If needed, use the Options menu to change it.



## Enter (clicking in canvas)

### Plotting a new measurement straight in the canvas

It is possible to add data to a canvas using a purely graphic way, by clicking in the canvas at the poles position. The new data are integrated to the set of data already plotted in the canvas (f.i. if you make some statistics on the data of the canvas, they are included in the statistic sample).

In Stem, 3 way to enter graphically new data :

- as the pole of a plane or a line ([new pole](#))
- as a plane, by its cyclographic trace, the pole of the plane being the mouse position ([new plane, by its pole](#))
- as a plane, by its cyclographic trace, via 2 clicked positions ([new plane, via 2 poles](#))



## New pole (axis or planes)

Enter clicking in canvas (axis or planes)

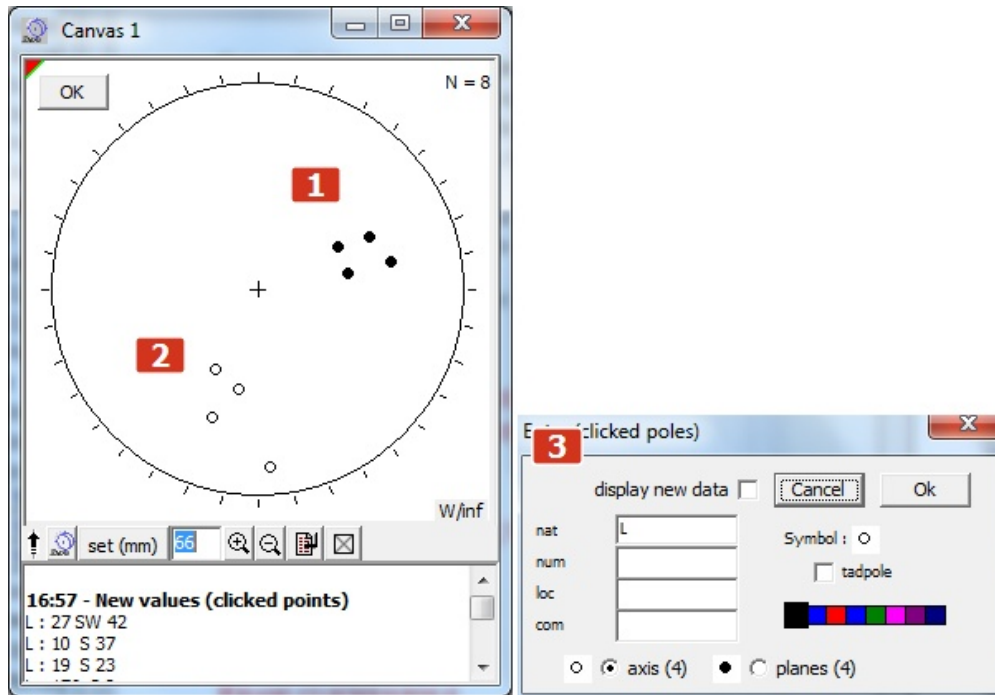


Fig. 7 Clicking in the canvas to add data - 1 - Two new sets of data

1. standard symbol for a plane (pole given by clicking in the canvas, shift key down)
2. standard symbol for a line
3. the dialog to fix the new data

You can add data to a canvas by clicking in it. The clicked point is interpreted as the pole of an axis (plain symbol) or, if the **shift key** is pressed, as the pole of a plane (black symbol).

Once done, press the "OK" button (top-left angle of the canvas window) to fix the points. A dialog lets you:

- display the added data in a new datasheet
- fix the codes for the new sets of axis and/or planes (check the radio button to select either the new axis or new planes)
- attribute a symbol to the new sets of axis and/or planes

## New plane (cyclo-trace tracking)

To add a plane defined by its cyclographic trace to a set of data

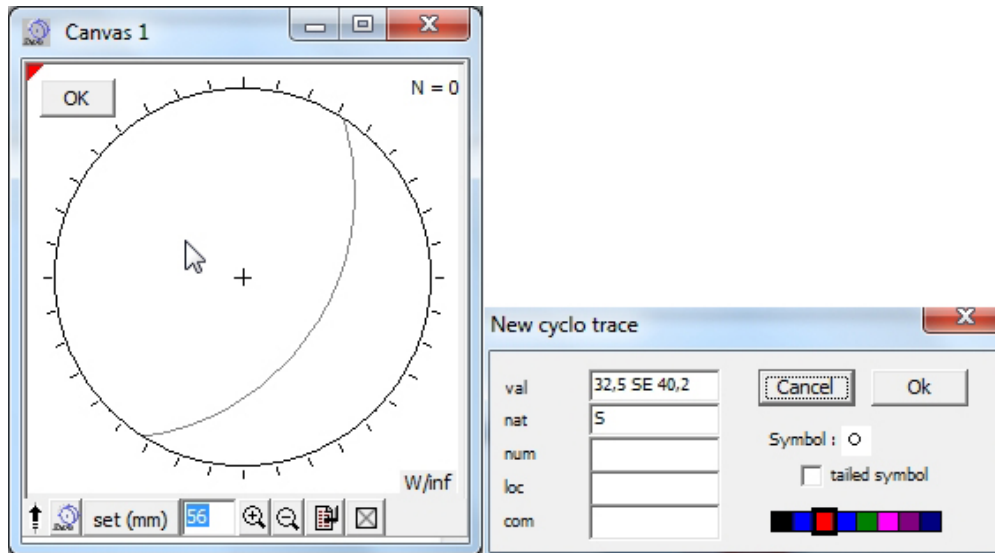


Fig. 8 Clicking in the canvas to add data - 2 - Tracking a cyclographic trace

To add in a canvas a plane defined by its cyclographic trace. When dragging the mouse, holding down the left button, the mouse position is interpreted as the position of the pole of the plane, and the cyclographic trace of the great circle follows accordingly. Once at the convenient position, press the "OK" button to fix the new data parameters.

## New plane (cyclo-trace via 2 points)

To add a plane defined by its cyclographic trace to a set of data

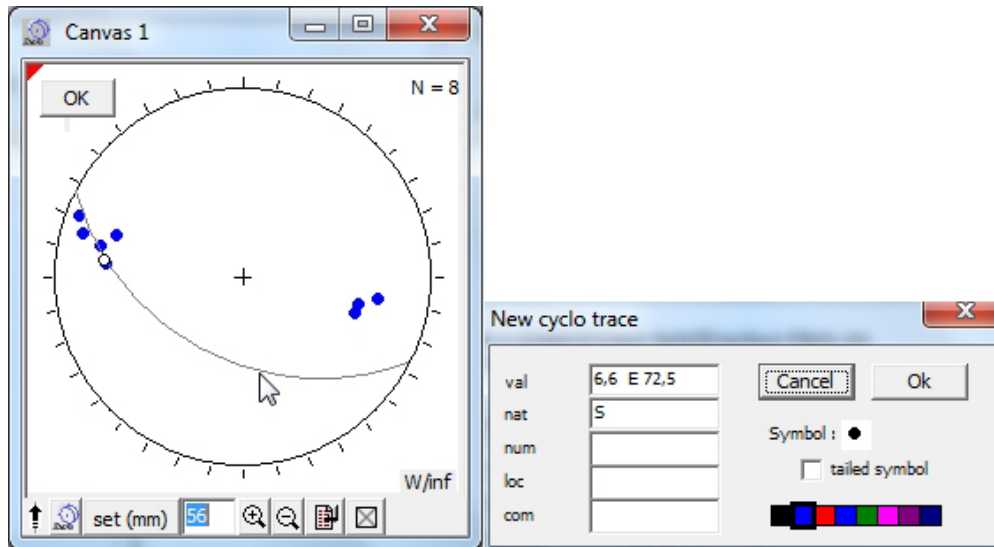


Fig. 9 Clicking in the canvas to add data - 3 - A new plane via 2 points

To add a plane defined by its cyclographic trace to a set of data. Click on a point in the canvas (on a pole already in the canvas, or at any other position). When dragging the mouse, mouse is followed by a great circle anchored at the first plotted position. Once at the convenient position, press the "OK" button to fix the new data parameters.

## Identify

A sub-menu to identify measurements plotted in a canvas

- Clicked point
- Clicked cyclographic trace
- Poles in lasso
- Given code
- Display code

## Clicked pole

### Identifying a clicked pole

The value corresponding to the clicked pole is given in the info part of the canvas window. You can repeat the action until the OK button is pressed.

**Shift key** turned on :

- the code "number" originally attributed to the value is written beside the clicked point (and not only in the lower "info" part of the canvas).
- if the clicked point does not correspond to a data previously plotted in the canvas, the azimuth and plunge of the clicked point (axis value) is displayed on the canvas. It is an easy and quick way (but not very accurate) to get the position of some particular point of the de canvas (f.i. the intersection of 2 cyclographic traces)

## Clicked cyclographic trace

### Identifying a plane displayed by its cyclographic trace

The measurement corresponding to the clicked trace is given in the info part of the canvas window.

The "number" code of the data is written on the cyclographic trace. You can repeat the action until the OK button is clicked down.

**Shift key** turned on : the measurement value is displayed in the canvas, instead of the code "number".

## Poles in lasso

### Identifying a set of poles

With the mouse, draw a line around the set of values that you want to identify. The measurements are given in the info part of the canvas window.

**Shift key** turned on when drawing the lasso : the data (with the associated codes) are listed in a new datasheet.

## Given code

Given code

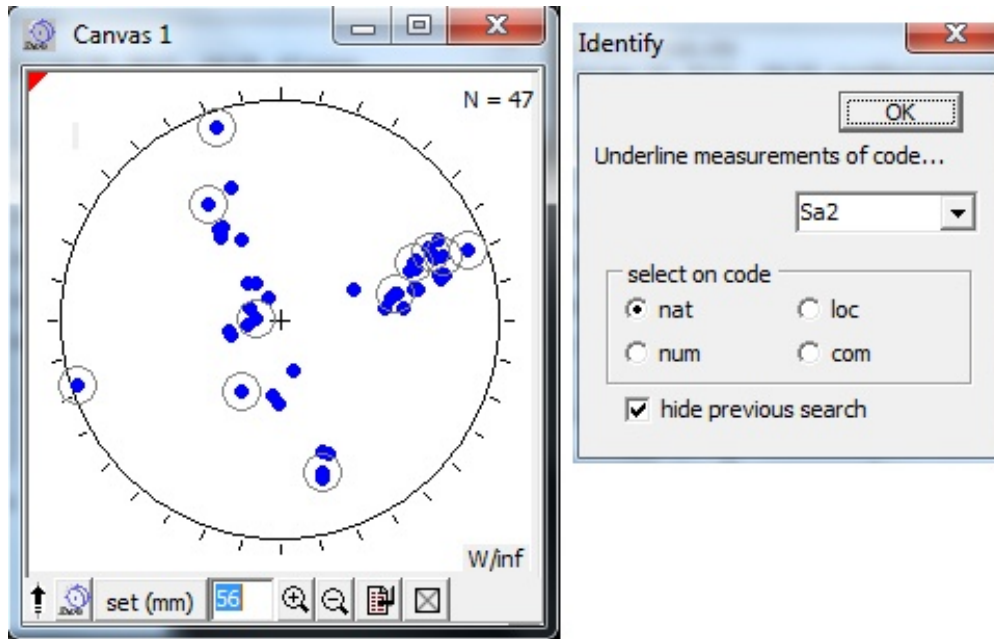


Fig. 10 Searching data having a given code

A dialog allows you to select a specific code. All the codes actually in the canvas are listed in the drop box.

The corresponding measurements in the active canvas are underlined in grey color (pole circled in grey, or, if the selection correspond to surfaces plotted by their cyclographic trace : trace underlined in grey).

Hide previous search : to erase the previous selection



## Plot code

Plot codes...

The code attached to the data is displayed in a new canvas, instead the pole of the measurement.

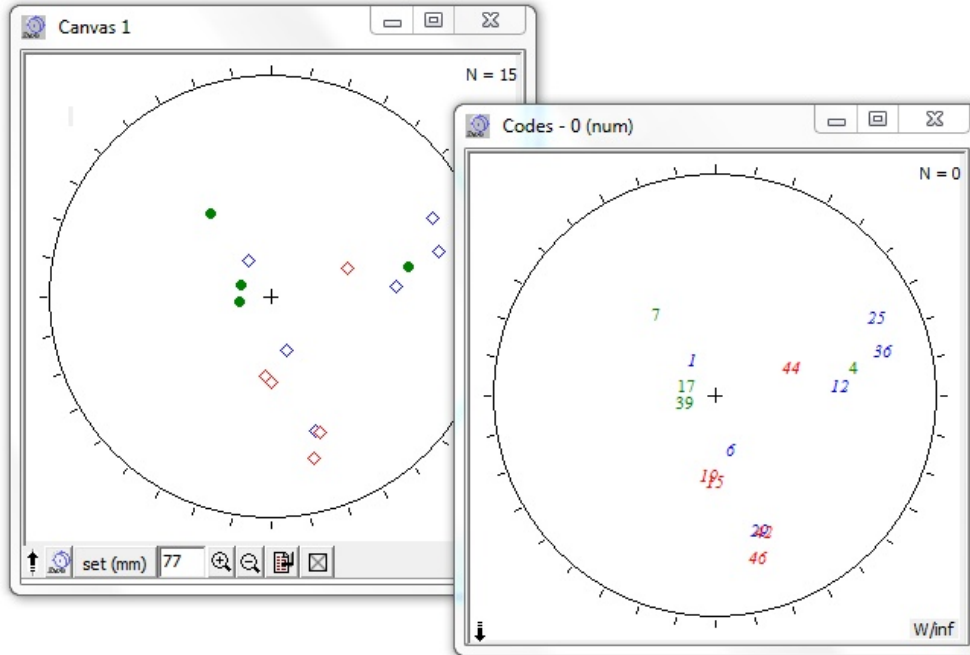


Fig. 11 Canvas displaying the "numbers" of the measurements

A new canvas displays the codes of the measurement (number, nature,...) in place of the initial symbols. Codes are written in the same color as the symbols of the initial canvas, surfaces are identified by italic characters.

## Modify

A way to modify or erase values in the canvas

- Erase clicked pole
- Erase clicked cyclographic trace
- Erase poles in lasso
- Erase selected symbols
- Keep poles in lasso
- Keep selected symbols
- Change symbols
- Shift pole/cyclo (set of planes)

## Erase clicked pole

Deleting values in the canvas (displayed by their pole)

Click on the pole that you want to erase. The corresponding measurement is given in the Edit part of the Plot window.



Undo only applies to the last deleted pole

## Erase cyclographic trace

Deleting values in the canvas (planes displayed by their cyclographic traces)

Click on the cyclographic trace that you want to erase. The corresponding measurement is given in the Edit part of the Plot window



Undo only applies to the last deleted trace

## Erase poles in lasso

### Deleting a set of poles

Draw a line (a lasso) around the poles you want to delete (to draw the lasso : drag the mouse while holding down its left button). The list of the corresponding measurements is given in the Edit part of the Plot window.

**Shift key** turned on when drawing the lasso : the erased data (with the associated codes) are listed in a new datasheet.

## Erase selected symbols

Deleting measurements displayed with a given symbol

If there are several sets of data plotted in the canvas (i.e. sets of data drawn with different symbols), the “[select symbols](#)” dialog is displayed to select the sets of data to erase.

## Keep only poles in lasso

### Keeping a set of poles

Drag the mouse to draw a line (a lasso) around the poles you want to keep. All the other poles will be erased. The list of the erased measurements is given in the Edit part of the Plot window.

**Shift key** turned on when drawing the lasso : the selected data (with the associated codes) are listed in a new datasheet.

## Keep selected symbols

Keeping only measurements displayed with a given symbol

If there are several sets of data plotted in the canvas (i.e. data with different symbols), the “[select symbols](#)” dialog is displayed to select the sets to erase



## Change symbols

To modify the symbols currently used in the canvas

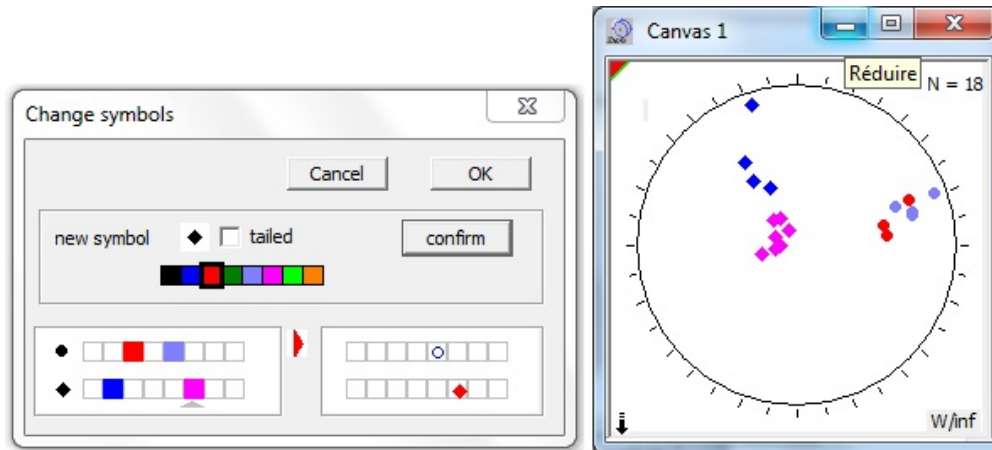


Fig. 12 Changing the current symbols

A dialog displays the symbols used in the active canvas (left box). Select a symbol you wish to change (click in the colored square), then choose in the upper box a new symbol. Confirm your choice (button confirm) : the new choice is displayed in the right box. You can do it at turn for each symbol you wish to modify. Once completed, click the OK button : the canvas is redrawn with the new symbols.

In the given example : the plain red circles will be changed for filled red circles, and the pink diamonds will be changed for red diamonds.



**Caution** : no undo function. You have to use again the same Change dialog to come back to the initial symbols.

## Rotation

Rotating data displayed in the canvas around a given axis

A dialog is displayed, to enter the rotation axis position and to select options

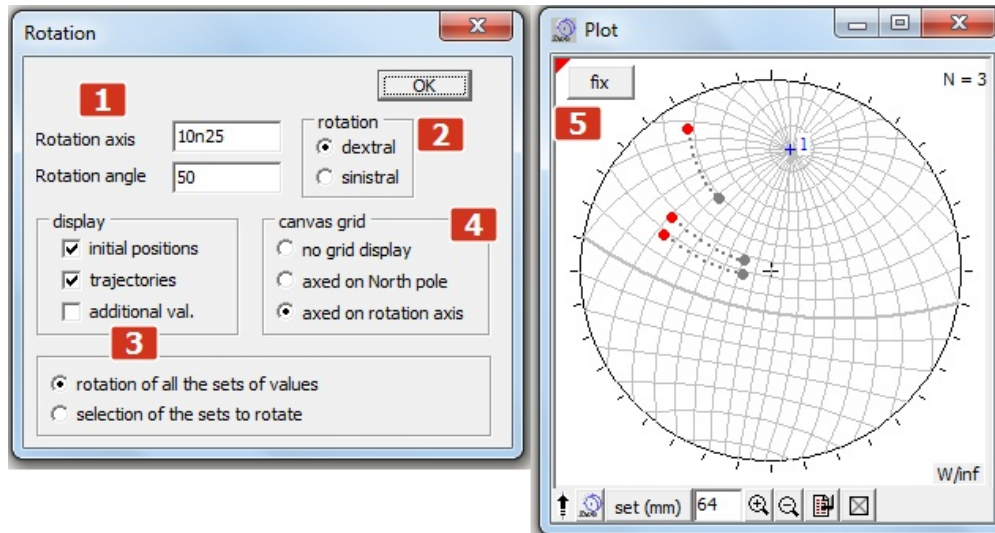


Fig. 13 Rotation dialog

1. Rotation axis position, rotation value
2. Sense of rotation
3. Display options
4. Background grid option
5. The "fix" button, to accept the new positions

### Dextral/sinistral

To fix the sense of rotation (clockwise/anticlockwise) : in lower hemisphere projection, it is the sense of rotation when looking downwards (i.e. from the direction of the pole of the rotation axis towards the poles of the plotted values). The sense is inverted if you work in the upper hemisphere projection. In the above example (Wulff, lower hemisphere), the rotations is dextral.

### Display options

It is possible to draw:

- the initial positions : the position of the poles prior to rotation are displayed in the canvas (in grey color, as in above example)
- the poles trajectories : the rotation of each pole is displayed (dashed line, a dot every 5°, as in example)
- the additional values after rotation : if some extra values (best fits) appear in the initial canvas (and only those ones, even if some other ones have been previously calculated but are not displayed)

at the moment), they are rotated together with the other values. They are displayed in the canvas only if the "display additional values" box is checked. If not, you can make them visible later, using the [set extra values](#) function

- Selection of the sets of values : when several sets of values are plotted, distinguished either by different symbols or different colors in the canvas, it is possible to rotate either all the values, or only some selected sets (chosen via a sub-dialog).

### Canvas grid

To display the canvas grid, either a standard one (axed on the North pole of the canvas), or an oblate one (axed on the rotation pole, as in above example).

### Example

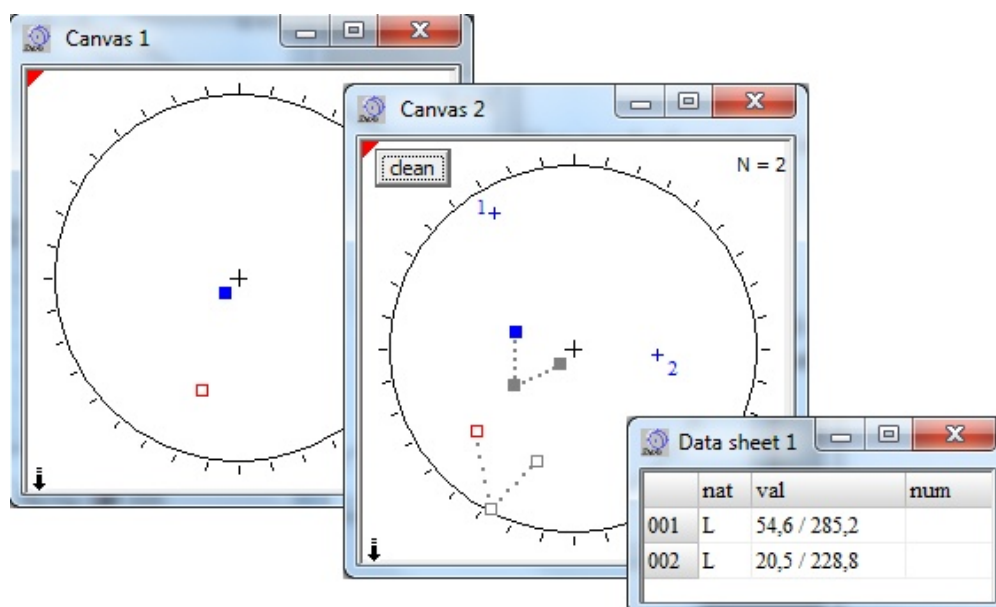


Fig. 14 Rotation window

The rotated values are displayed in a new canvas, and can be at turn rotated again (given example: a first dextral rotation of  $30^\circ$  around an axis 10/330, followed by a dextral rotation of  $30^\circ$  around an axis 40/095). The successive poles of rotation are plotted and labeled. Grey symbols : to keep the initial position of the poles and to underline the rotation trace.

Use the "fix" button, to fix the rotated positions. If you proceed then to some other rotations, rotated values are displayed in a new canvas.

When clicking the 'fix' button, it changes to 'clean'. You can click in it to erase the initial poles and traces of rotation.

If you hold down the [shift key](#) when clicking the 'fix' button, the rotated values are displayed in a new data sheet.

Even if the planes are given by their cyclographic trace, it's their poles which are plotted in the rotated canvas. When cleaning the canvas ("clean" button), the cyclographic traces of the planes will be redrawn instead of the poles.

### Undo after rotations

If you have done more than 1 rotation, undo will make the rotations opposite to the previous ones : you come back to the successive previous positions, starting by the last rotation. Once back to the initial position, a new call to undo will come back to the position as calculated after the last rotation. You can undo either before or after you have clicked in the "fix" button.

## Other graphical utilities

### Some geometrical constructions

A set of functions to do some geometrical constructions. The 2 first ones are already available in the “[Line-plane value](#)” utility, but now constructions deal with measurements plotted in the canvas, selected using the mouse, and results can be added to the list of data.

- [Intersection of 2 planes](#)
- [Plane defined by 2 lines](#)
- [Bisector plane \(2 cyclo traces\)](#)
- [Bisector line \(2 poles\)](#)
- [Small/great circle intersection](#)
- [Clicked cyclo trace, show pole](#)
- [Clicked pole, show cyclographic trace](#)

## Intersection of 2 planes

Finding the intersection of 2 cyclographic traces

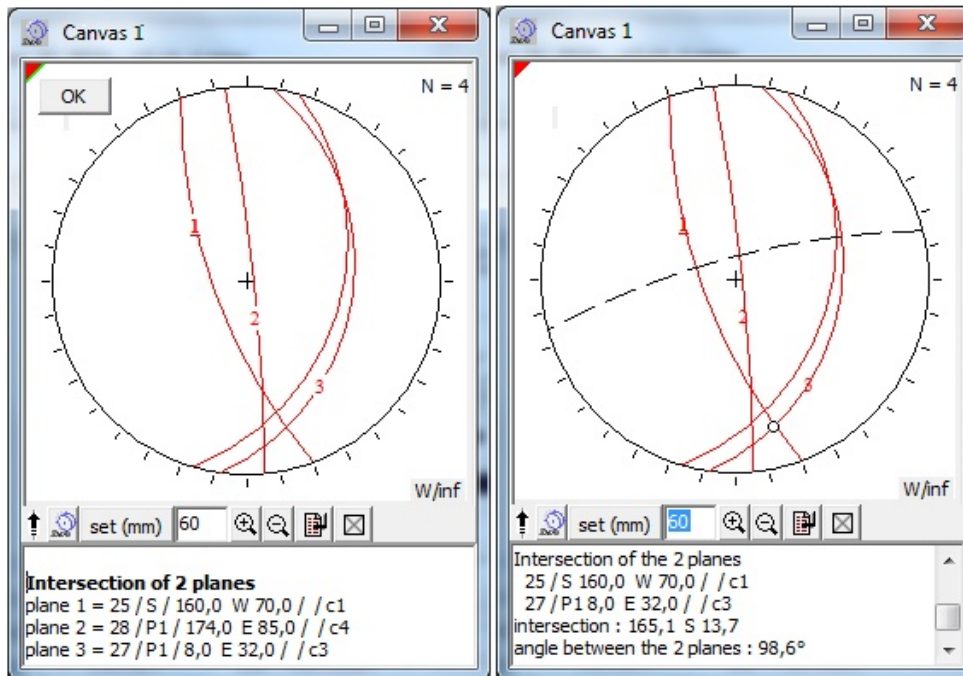


Fig. 15 Intersection of 2 planes

Click on a cyclographic trace to select a first plane, labeled 1. The data is given in the info part of the window (plane 1). Click on a second trace (or a third one...). It will be labeled 2 (or 3...). Click in the OK button to display the pole of the intersection of the first and last clicked cyclographic traces (given example: traces 1 and 3), together with the cyclographic trace of the plane perpendicular to the intersection (dotted trace). The position of the intersection and the angle between the two planes are given in the info zone. The **intersection line can be added to the data** (a dialog let you fix its symbol and related codes).

If you hold down the [shift key](#) when clicking the OK button, the intersection line is not added to the other data, but to the list of additional values attached to the canvas. Use the [Set extra values](#) function to display (or erase) it and the associated plane.

See also [Plane defined by 2 lines](#).

## Plane defined by 2 lines

Finding the plane defined by two poles

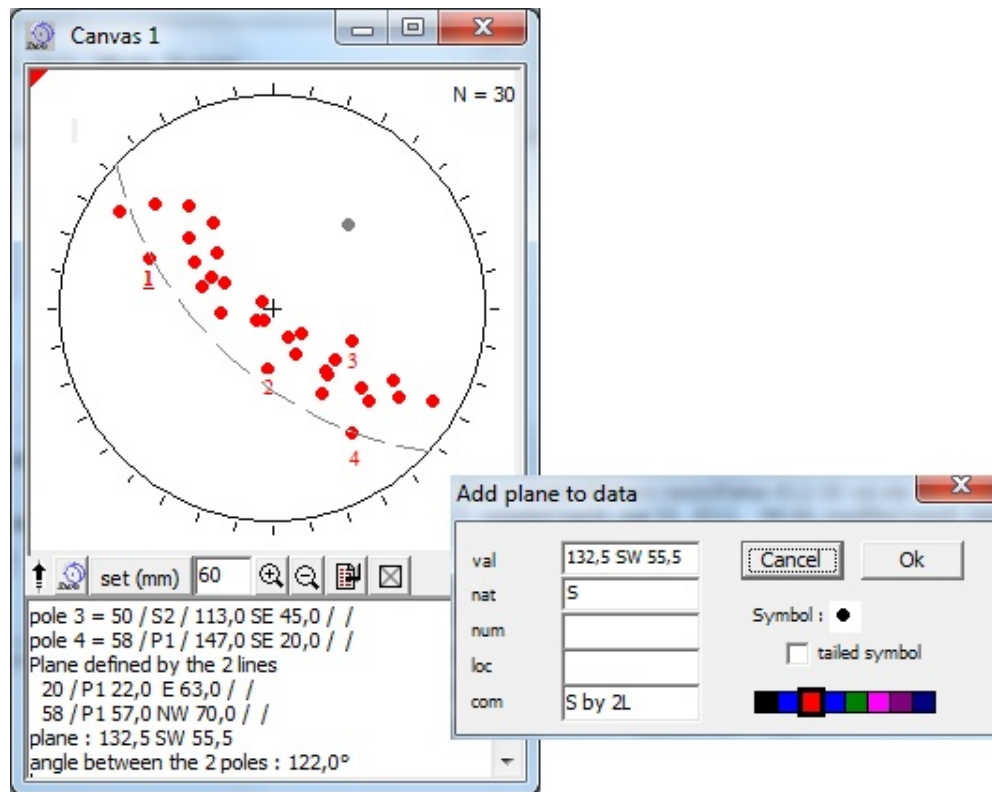


Fig. 16 Plane defined by 2 clicked pole

Click on a pole to select a first line (pole of an axis or pole of a plane). It is labeled 1, and the corresponding measurement is listed in the info part of the window (plane 1). (pole 1). Click on a second pole (or a third one...). It is labeled 2 (or 3...), and the corresponding measurement is added to the list in the info part (pole 2, 3..). Then click in the OK button to display the cyclographic trace of the plane defined by the first and last clicked poles, in the given example 1 and 4). **The plane can be added to the data.** A dialog let you choose its symbol and related codes.

If you hold down the [shift key](#) when clicking the OK button, the plane is not added to the other data, but to the list of additional values attached to the canvas. Use the [Set extra values](#) function to display (or erase) it and its pole.

See also [Intersection of 2 planes](#)

## Bisector plane (2 cyclographic traces)

Finding the bisector of two cyclographic traces

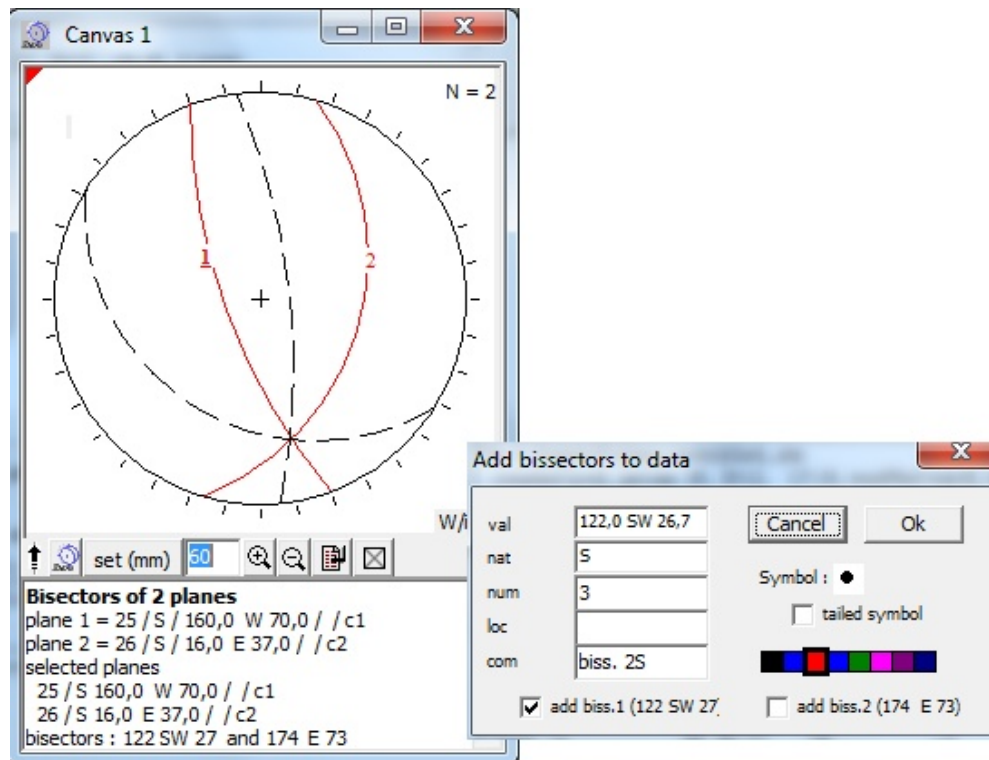


Fig. 17 Bisectors of 2 planes

Click on a cyclographic trace to select a first plane. It is labeled 1, and the corresponding measurement is listed in the info part of the window (plane 1). Click on a second trace (or a third one...). It is labeled 2 (or 3...), and the corresponding measurement is added to the list in the info part (plane 2, 3...). Then click in the OK button to display the two bisector planes of the first and last clicked cyclographic traces. They can be added to the data : a dialog let you choose which bisectors to add, together with its symbol and related codes.

If you hold down the [shift key](#) when clicking the OK button, the bisectors are not added to the other data, but to the list of additional values attached to the canvas. Use the [Set extra values](#) function to display (or erase) them and their poles.

See also [Bisector lines \(2 poles\)](#)



## Bisector line (2 poles)

Finding the bisectors of two poles

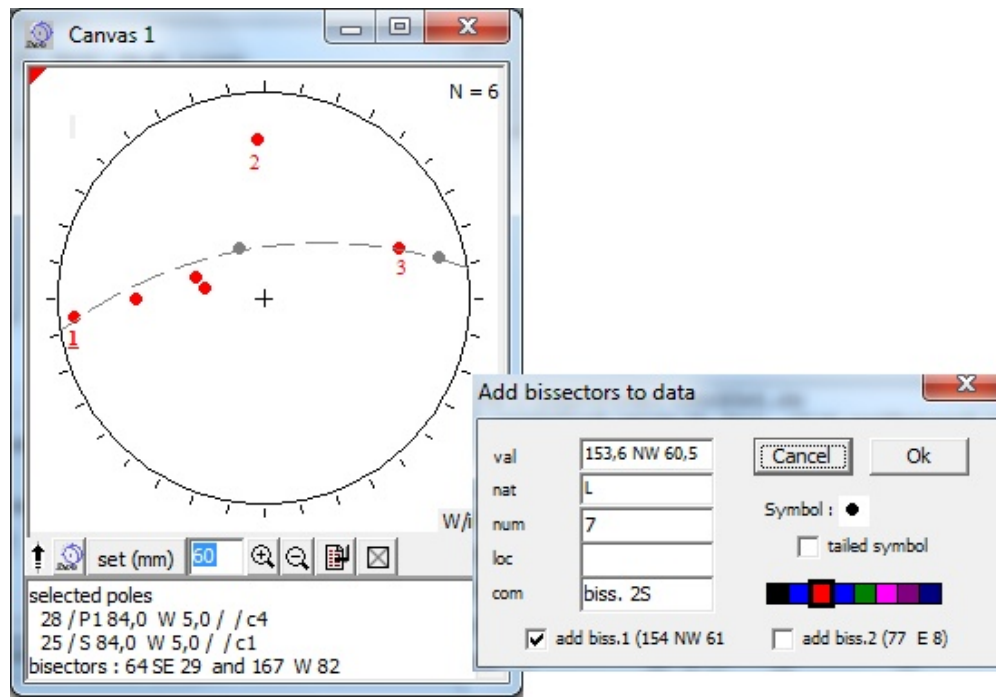


Fig. 18 Bisectors of 2 poles

Click on a pole to select a first line (pole of an axis or pole of a plane). It is labeled 1, and the corresponding measurement is listed in the info part of the window (pole 1). Click on a second pole (or a third one...). It is labeled 2 (or 3...), and the corresponding measurement is added to the list in the info part (pole 2, 3...). Then click in the OK button to display the 2 poles of the 2 bisectors and the cyclographic trace running through the 2 selected poles and the 2 bisectors. The bisectors can be added to the data : a dialog let you choose which bisectors to add, together with its symbol and related codes.

If you hold down the [shift key](#) when clicking the OK button, the bisectors are not added to the other data, but to the list of additional values attached to the canvas. Use the [Set extra values](#) function to display (or erase) their poles.

See also [Bisector \(2 cyclo traces\)](#)

## Small circle/great circle intersection

Finding the intersections between the cyclographic trace of a plane and a small circle

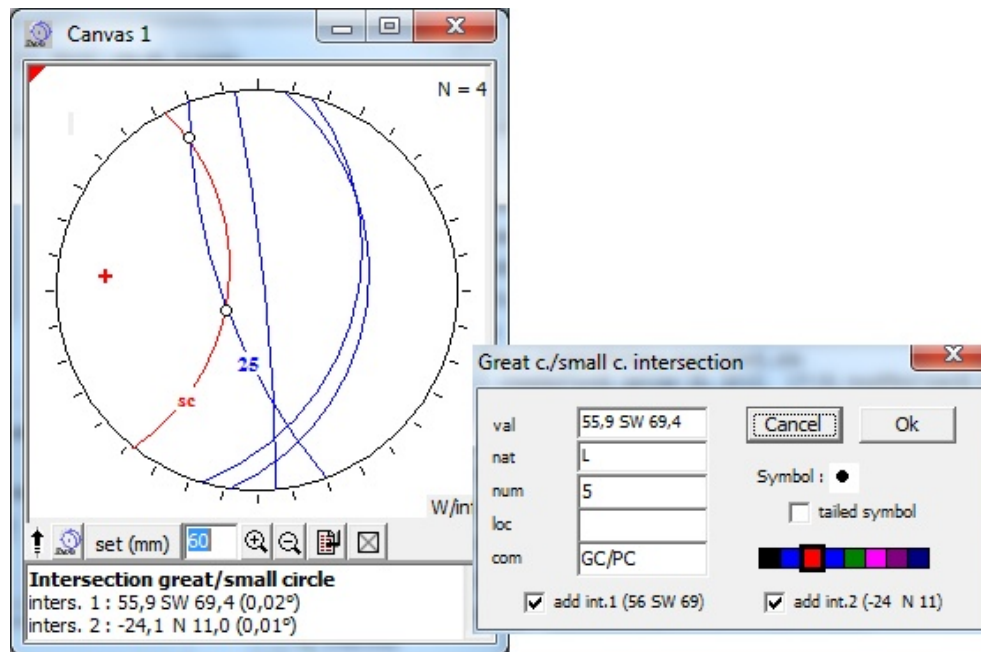


Fig. 19 Intersection between a great circle (a cyclographic trace) and a small circle  
The small circle can be either the result of a calculation ([best fitting of a small circle](#) or a girdle distribution), or have been [added graphically](#) in the canvas. The great circle is the cyclographic trace of a plane.

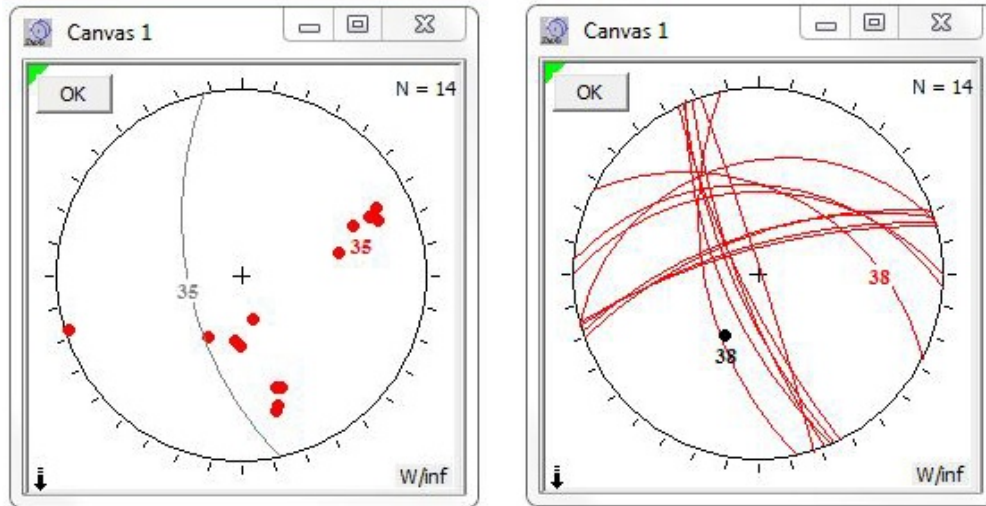
Click on a cyclographic trace to select a plane. It will be labeled by its code " number" . Click on the small-circle. It will be labeled " sc" . Then click the OK button to display the intersections (1 or 2) between the small and great circle. The intersections can be added to the data : a dialog let you choose which intersection(s) to add, together with their symbol and related codes.

If you hold down the [shift key](#) when clicking the OK button, the intersections are not added to the other data, but to the list of additional values attached to the canvas. Use the [Set extra values](#) function to display (or erase) them.

## Clicked cyclo trace : show pole

Clicked cyclo trace : show pole & Clicked pole : show cyclo trace

When a plane is displayed by its cyclographic trace, display of its pole; when a plane is displayed by its pole, display its cyclographic trace



When planes are displayed by their cyclographic trace: click on a trace to select a plane. It will be labeled with its code " number" . Its pole will be displayed, labeled with the same code " number" .  
 When planes are displayed by their pole: click on any pole in the canvas (indifferently pole of a plane or pole of an axis) to display the equivalent cyclographic trace. Both the pole and the trace are labeled with the code " number" .

## Display net

### Enhancing the canvas with parallels and meridians net

To display in the canvas a background grid. It can be

- a cyclographic net
- a polar net
- an oblate net, centered either on the clicked point, or on a given axis value.

Mesh and color of the grid (10, 5 or 2°) can be changed in the [Options](#) menu. The grid can be [indexed](#) (along the Equator and N-S meridian) and [erased](#).

- [Standard](#)
- [Polar](#)
- [Axed on clicked position](#)
- [Axed on a given axis](#)

All these functions are also available from the plot window pop-up menu (right click in the canvas).

## Standard

To display the usual Wulff or Schmidt net

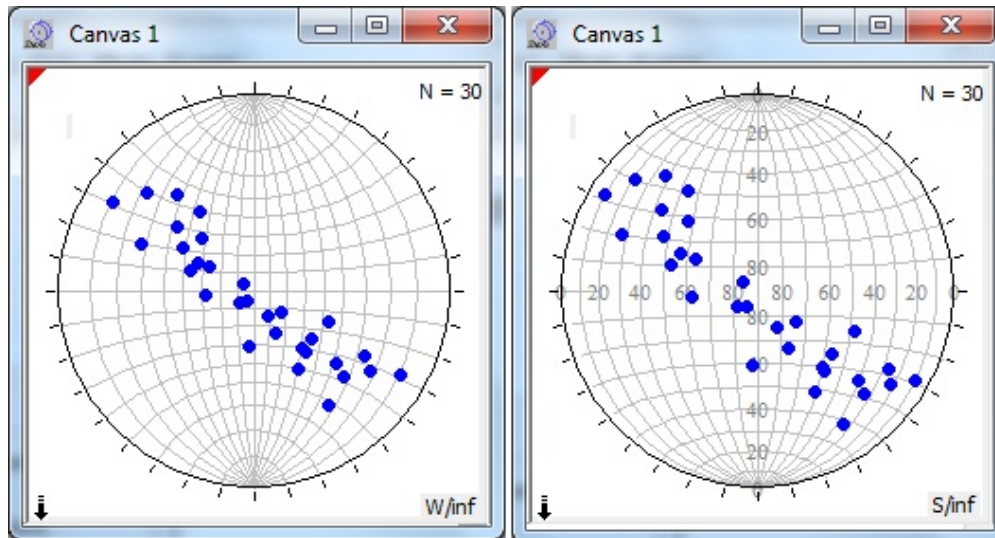


Fig. 20 Wulff canvas (left) and indexed Schmidt canvas (right)

## Polar

To display a polar grid instead of the usual Wulff or Schmidt net

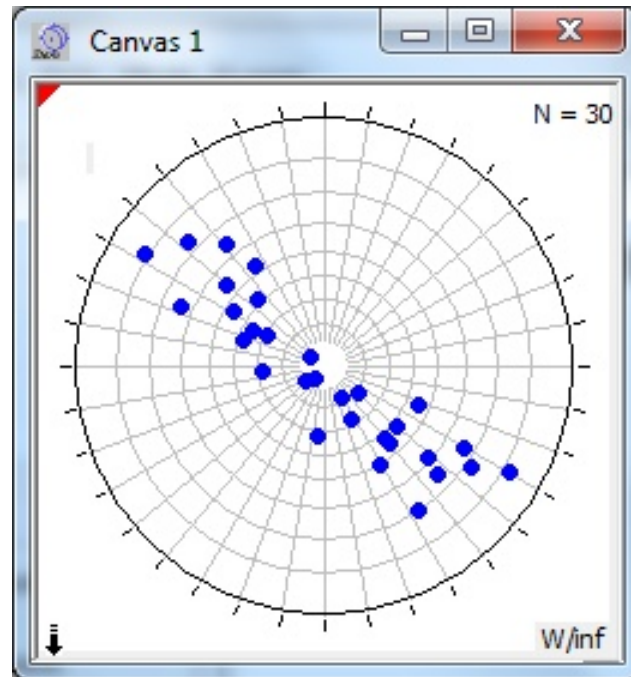


Fig. 21 Polar grid, stereographic projection

## Axed on clicked position

To display an oblate grid instead of the usual Wulff or Schmidt net

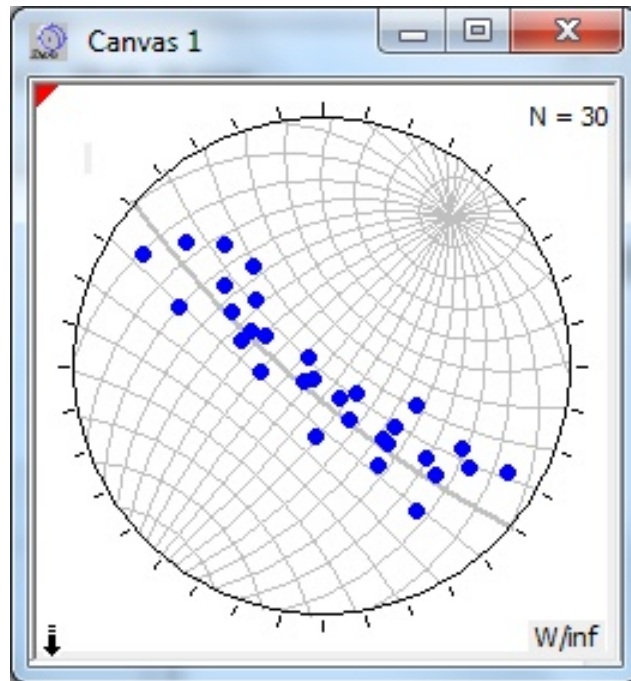


Fig. 22 An oblate canvas (stereographic projection)

To choose the position of the grid axis, click in the canvas (multiple trials allowed), then OK button

## Axed on given axis

To display an oblate grid instead of the usual Wulff or Schmidt net  
A dialog let you choose the position of the grid axis.



## Indexed grid

To label the grid meridians and parallels

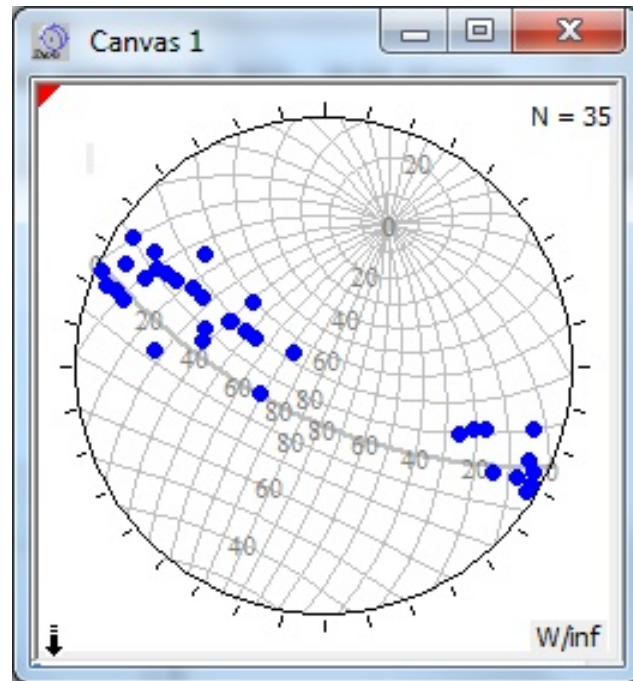


Fig. 23 An oblate grid, indexed (cyclographic projection)

Tick the “ Indexed grid” menu item to index (or un-index) the grid.

## Erase net

To erase the background grid

## Clean

To clean the temporary drawings

Temporary drawings can be the lasso, the trajectories of the points during rotation, the clusters initial seals, ....

To erase (or redraw) extra values or best fits, use the [Display best fits](#) function.

## Menu Stats 3D

Statistical functions for common 3D distributions

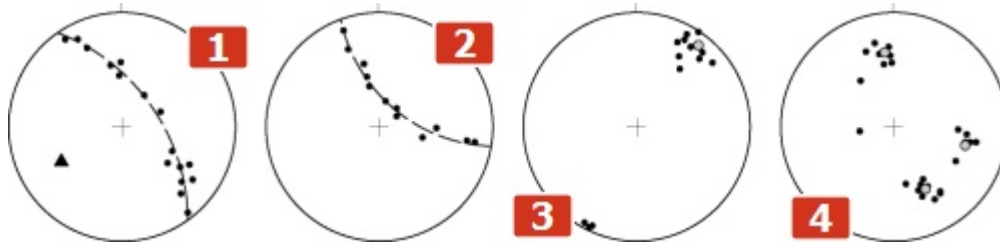


Fig. 24 Some simple 3D distributions (girdle, axial, clustered)

- 1 . girdle (great circle)
- 2 . girdle (small circle)
- 3 . uniaxial
- 4 . clusters

The functions<sup>1</sup> in this menu provide the most frequently used statistical functions : calculation of the **best axis** (for an axial distribution), of the best plane adjusted through a set of lines (**best great circle**, in the case of girdle type distribution) or of the best conical surface through a set of lines (**best small circle**, in the case of a small circle type distribution, the classical example being a conical fold). This menu provides also functions to build a **density diagram** and to draw **density contours**. At last, a function allows the automatic best repartition of a **clustered distribution** in clusters, and gives the best axis for each of the clusters.

Some other more rarely-used statistical functions are found in the **Other 3D stats** menu. For instance, automatic search of the best small/great circle, to estimate if it is actually a great circle or rather a small circle which better fit a girdle type distribution. Or a bootstrap approach to estimate the error on a great or small circle determination.

- **Best pole**
- **Best great circle**
- **Best small circle**
- **Clusters**
- **Fit graphically a small/great circle**
- **Others 3D stats**
- **Counting**
- **Countouring**
- **Display best fits**

<sup>1</sup> A lot of complementary informations about 3D Stats can be found for instance in : Fisher, N.I., Lewis, T.L. and Embleton, B.J.J., 1987, Statistical analysis of spherical data, 328 p., Cambridge University Press



## Best pole

Calculation of the best axis/plane following the Kirali method (resolution of the orientation matrix)

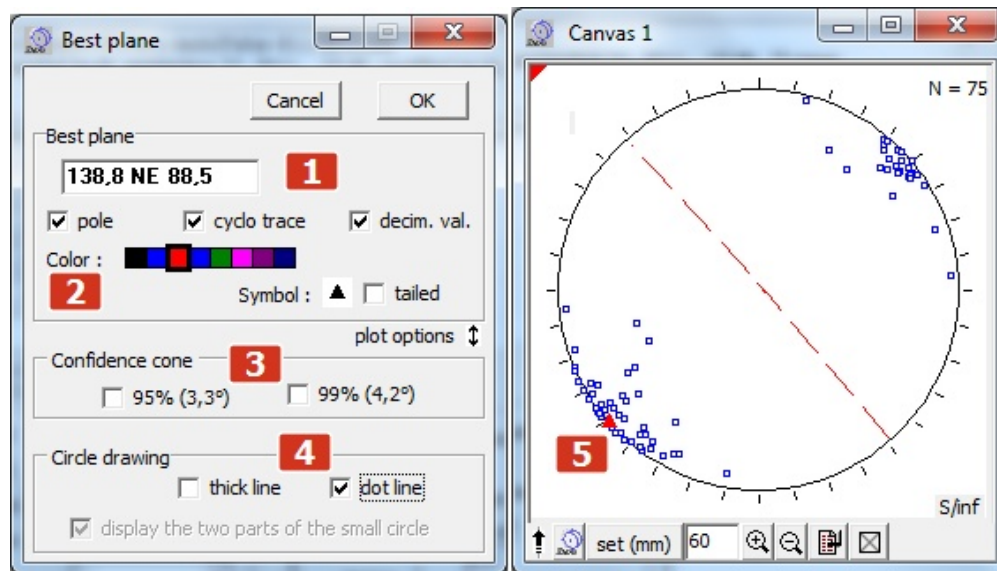


Fig. 25 Axial distribution, calculated best plane

1. the best plane (decimal value checked)
2. To fix its symbol, and the element to plot (pole and-or tcylographic trace of the best plane)
3. Confidence cones values. Drawn if the box is checked
4. Style of the cyclographic trace
5. pole of the best plane

If the canvas contains more than one symbol, the "select dialog" allows the selection of the symbols to keep in the calculation. Another dialog (figure) gives the result (also given in the info part of the plot window) and allows several plot options.

**Confidence cone** - Given value ( $P = 95\%$  or  $P = 99\%$ ) is the semi- angle of a circular confidence cone, calculated from normalised eigenvalues of the orientation matrix. It is implicitly based on the assumption of symmetry for the distribution ([Watson distribution](#)). You can test this assumption via the " [Test rotationnal symmetry](#)" function.

If the last data in the set of measurements is an axis (identified by the first character of the nature code), the result is given as a "best axis", otherwise as a "best plane" (as above).

- Best axis : you can plot the axis, the confidence cones, the cyclographic trace of the plane perpendicular to the calculated axis
- Best plane : you can plot the cyclographic trace and/or the pole of the plane, the confidence cones.

It is important not to confuse best plane (in the case of an uniaxial distribution of the poles of a set of planes) with best great circle (in the case of a girdle distribution of the set of poles)  
Even if you do not plot now all the elements, you can do it later, using the [Display best fits](#) function.

## Best great circle

Calculation of the great circle (cyclographic trace of a plane) best adjusted to a set of poles of lines

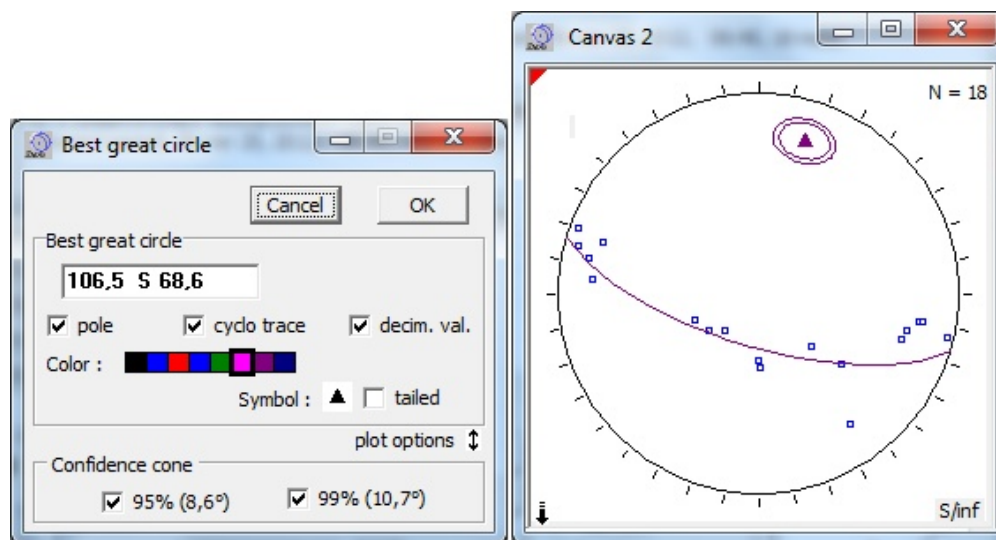


Fig. 26 Fold axis estimated using calculation of the best great circle

Best great circle is typically used to reconstruct the axis of a cylindrical fold from strata measurements.

Two methods are provided (selection of the method in the [Options](#) menu):

- The Kirali method (resolution of the orientations matrix) as used for the best pole calculation, the normal to the plane (represented by the best great circle) being given by the eigen vector corresponding to the smaller eigen value of the matrix. This method can lead to inconsistent results when the number of data is very low (f.i. only 3 points),

- Minimisation of the poles-great circle distances (same way of proceeding as for the best small circle). This method can be used even if there is only a small number of data (even if only 2 poles !).

**Confidence cone** - Given value ( $P = 95\%$  or  $P = 99\%$ ) is the semi-angle of a circular confidence cone, calculated from normalized eigenvalues of the orientation matrix. It is implicitly based on the assumption of symmetry for the distribution ([Watson girdle model](#)). You can test this assumption via the “[Test rotational symmetry](#)” function.



## Best small circle

### Calculation of the small circle best adjusted to a set of poles

Best small circle is typically used to reconstruct the axis of a conical fold from strata measurements. Best small circle calculation is an iterative process, number maximum of iterations being arbitrarily fixed to 2000 in Stem. If this number is reached before stabilization of the calculation, an alert is displayed. It gives you the small circle obtained at this stage of the calculation. You can choose to keep it, or to abort the calculation.

Reaching the maximum number of iterations is a very rare case. It might only occur for a very large set of data (> 1000), and even in that case, the given value is a good estimation of the actual best small circle (error within few degrees).

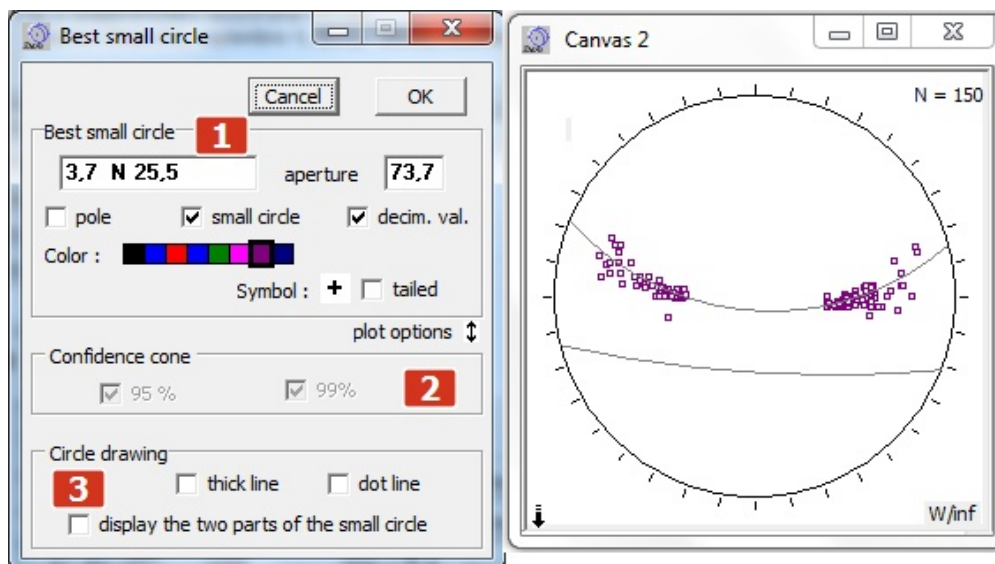
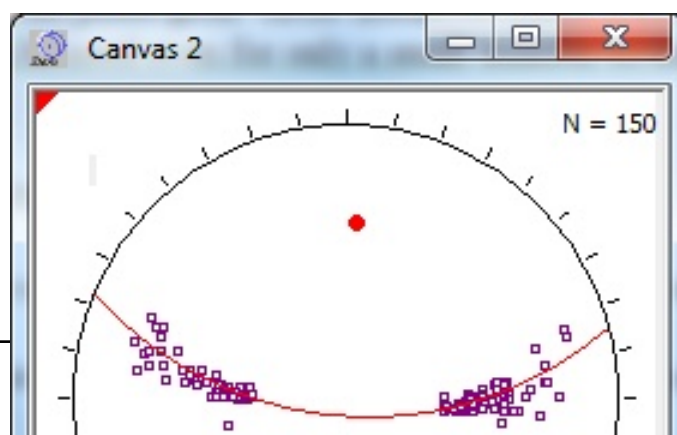


Fig. 27 Best small circle - 1 - the 2 parts of the cone

1. the value and the display options of the best small circle
2. No straight calculation of confidence intervals
3. To keep or not the 2 arcs making the small circle

Once the calculation completed, a dialog let you fix the display options (above). As compared to the [Best great circle](#) or [Best pole](#) dialogs, a new option appears for a small circle. Actually, a small circle is often made of 2 arcs (when the aperture of the cone is larger than its plunge). Only one of them has a geological meaning (the one passing through the set of poles), and normally it isn't very useful to draw the 2 arcs. Except if you request the drawing of the 2 arcs, Stem automatically keeps the convenient arc (below).



There is no straightforward way to calculate the confidence cone for the axis position, neither the confidence interval on the overture of the cone. Stem provides a bootstrap approach to estimate those errors (in the given example, around  $5^\circ$ ) : see the function "[Error on small circle](#)".

## Fit graphically a small/great circle

To fit manually a great/small circle to a set of data

Sometimes, automatic calculation of a best great circle (or a best small circle) doesn't properly reflect the structure of the set of measurements plotted in a canvas (a cloud of poles). In some cases (f.i. , folded structure with some dispersion of the poles due to superposition of several steps of folding), a visual analysis can be more convenient to identify and characterizes subsets in the bulk set of data.

This sub-menu provides tools to adjust manually a great circle (or a small circle) through a cloud of points, all of them or part of them following a girdle distribution. The way to position the great circle with the mouse is the same as it is in the [Enter \(clicking in canvas\)](#) functions. But now, the visually fitted circle will be added to the [best fit list](#) (and not to the other measurements). You can determine the poles which are close to the circle.

- [Great circle \(mouse tracking\)](#)
- [Great circle \(via 2 points\)](#)
- [Small circle \(using a grid\)](#)
- [Small circle \(via 3 points\)](#)

## Great circle (mouse tracking)

Setting manually a great circle

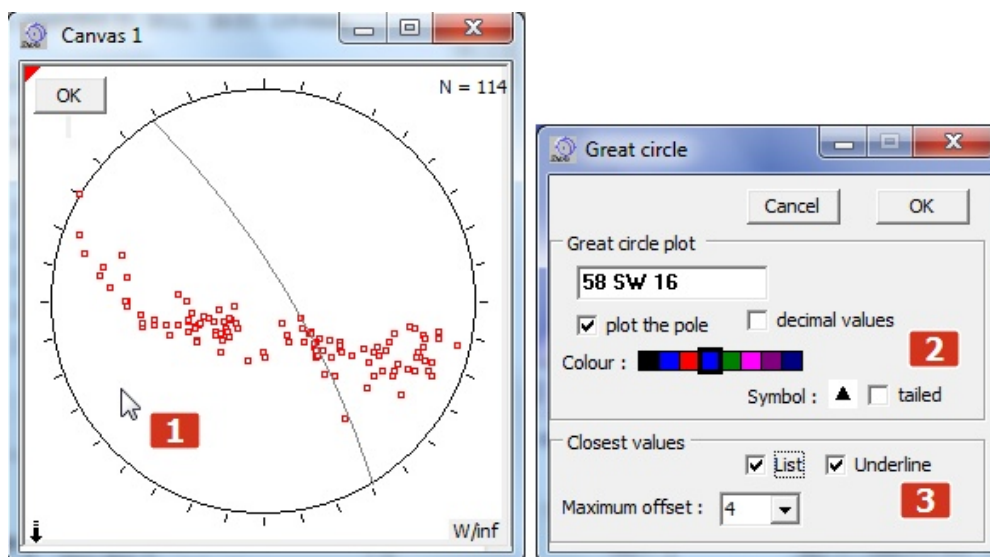


Fig. 29 Fixing manually a great circle

1. Mouse cursor, pole of the great circle
2. Symbol for the great circle
3. Options, to find the poles close to the great circle

When dragging the mouse, holding down the left button, the mouse position is interpreted as the position of the pole of a plane, and the trace of the great circle (the cyclographic trace) follows accordingly. Once at the convenient position, press the "OK" button to display the dialog to fix the display parameters.

Closest values : to identify the measurements which poles are close to the great circle (i.e. at an angle less than the " maximum offset" ). Tick the list checkbox to write the selected values in a new datasheet. Tick the underline checkbox to draw a circle around those values.

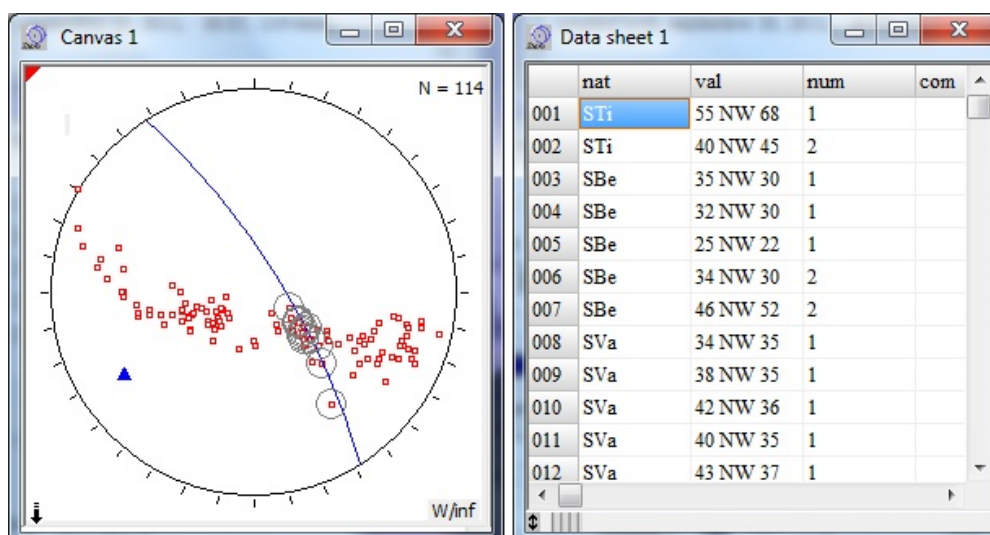


Fig. 30 Data close to the circle



## Great circle (via 2 points)

### Setting manually a great circle via 2 points

Click on a point in the canvas (on a pole already in the canvas, or at any other position). When dragging the mouse, it is followed by a great circle anchored to the first pointed down position. Once at the convenient position, press the "OK" button to display the dialog to fix the great circle display parameters (see [Great circle, mouse tracking](#)).

Closest values : to identify the measurements which poles are close to the great circle (i.e. at an angle less than the " maximum offset" ). Tick the list checkbox to write the values in a new datasheet. Tick the underline checkbox to draw a circle around those values.

## Small circle (using a grid)

Setting manually a small circle

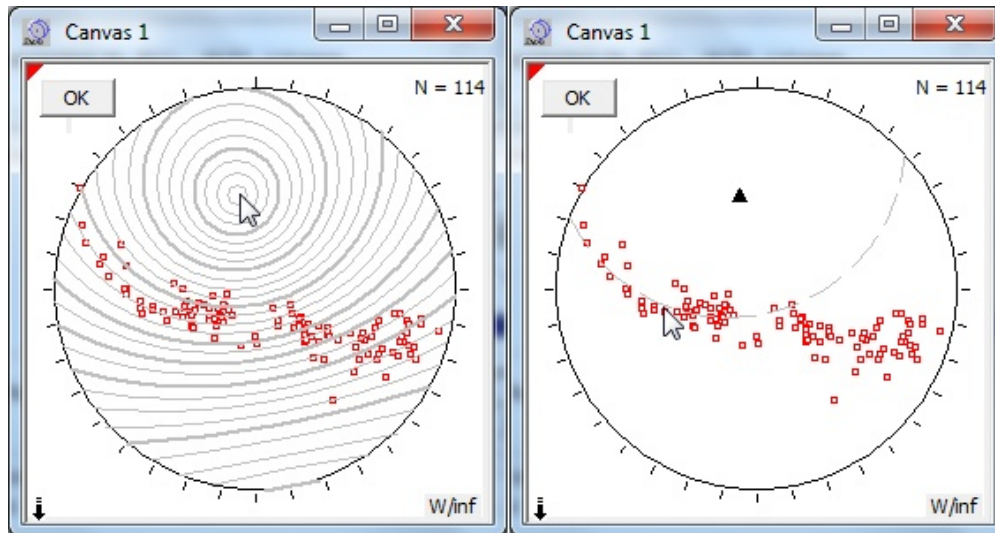
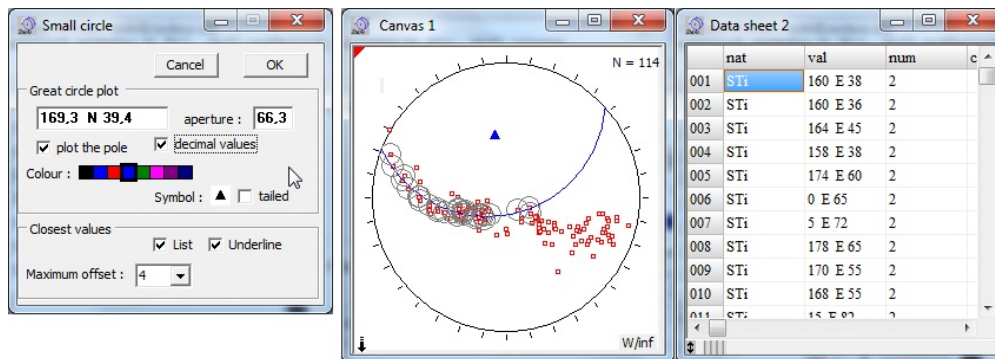


Fig. 31 Choice of the small circle

Click in the canvas. A set of small circles is drawn. It follows the mouse pointer when you drag it. Once a small circle at the convenient position, stop dragging the mouse, and click on the convenient small circle to fix it; then press the "OK" button to display the dialog to choose the circle display parameters.



Closest values : to identify the measurements which poles are close to the small circle (i.e. depart less than the " maximum offset" from the circle). List checkbox : writing of the values in a new datasheet. Underline checkbox : drawing of a small grey circle around the poles of those values.

## Small circle (via 3 points)

Setting manually a small circle via 3 points

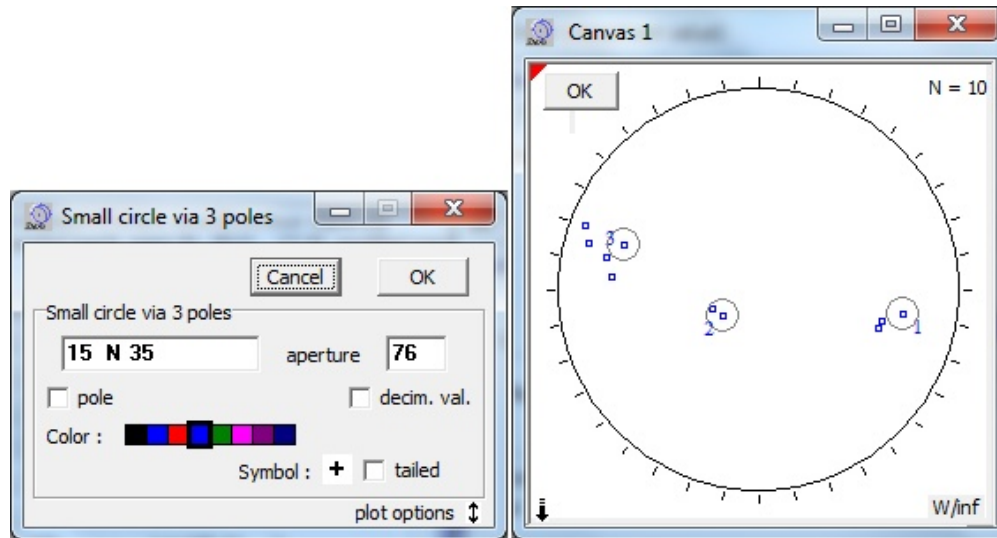


Fig. 32 Small circle running through 3 clicked positions

Click in the canvas to fix the 3 points : each clicked point can be a pole already in the canvas (a small grey circle is drawn around the pole, with the “ number” of the corresponding data beside, as in given example), or any other position (a small plain square is drawn, the line value is written beside the symbol). You must define at least 3 positions, but you can click more than 3 times. Click on OK to draw the small circle running through the last 3 positions. A dialog let you choose the circle display parameters.



## Clusters

### Best redistribution of data in N clusters

When plotted poles seems to be clustered, as in the given example (where data seems to belong to 3 clusters), the "Clusters" function provides automatic best splitting of the data in a given number N of clusters (N max = 6).

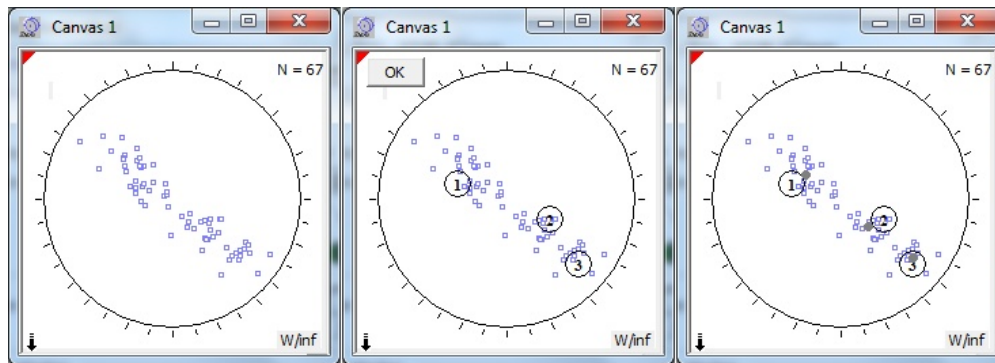


Fig. 33 Clustered distribution - 1

- Choose the N clusters "seals" by clicking in the canvas (given example, central canvas, seals 1 to 3). For a more stable result, don't select the seals too far from the estimate centers of the clouds. If needed, you can delete the last seal position using " Undo" (Ctrl Z), then the previous one, and so on down to the first seal. If you go on, all the seals will be redrawn.
- Click in the OK button to calculate by an iterative process the best repartition of the data between the N clusters. The best axis for each cluster are drawn, together with the position of the initial seals

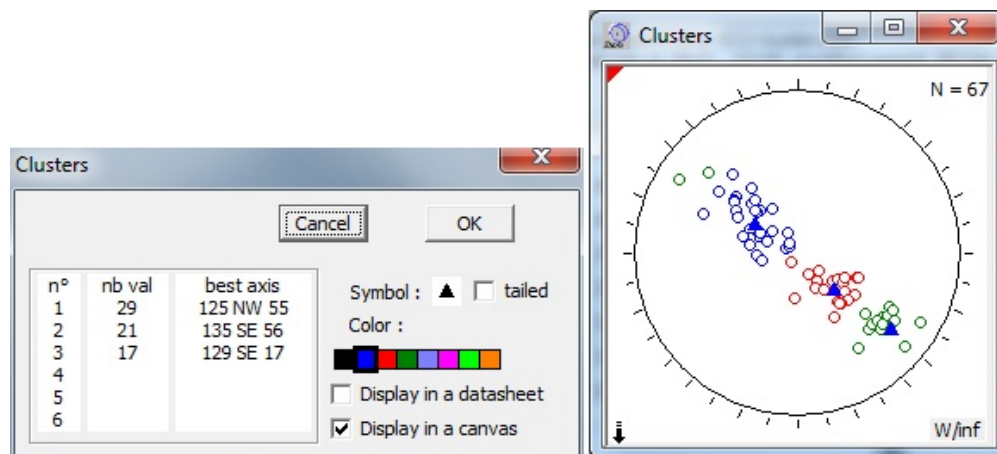


Fig. 34 Clusterdf distribution - 2

A dialog let you choose the display parameters.

The best axis values, as well as the number of data in each cloud, are listed both in the " info" part of the plot window and in the dialog.

If you want to identify the measurements attached to each cloud, check " display in datasheet" check

box (the values will be in N new datasheets) and/or “display in a canvas” check box (a new canvas is drawn, displaying the N clouds, each with a specific color, as in given example)

## Other 3D stats

### Some more rarely used statistical functions

For instance, automatic search to see if it is actually a great circle, or rather a small circle, which better fit a girdle type distribution. Or bootstrap approach to estimate the error on a great/small circle determination.

Several of the functions are specifically devoted to the Watson distribution, the principal model for an axial (i.e. bipolar) distribution, for undirected lines (axis) distributed with rotational symmetry in either bipolar (axial) or girdle form. A detailed analysis of this distribution is provided by Fisher et al., 1987. Some of Fisher's examples (mainly the set of data labelled B11, B12 and B14) have been used here.

- Eigen values analysis
- [Best circle distribution analysis](#)
- [Error on a great circle \(boot strap\)](#)
- [Error on a small circle \(boot strap\)](#)
- [Test rotational symmetry](#)
- [Watson analysis](#)
- [Outlier test](#)
- [Trackdip](#)

## Uniformity test - Eigen value analysis

Exploratory analysis of a spherical distribution according to the Eigen values of the orientation matrix

Test of uniformity against an axial (bipolar) or girdle alternative

When a distribution seems to be rather uniform, a test to check if the data are actually randomly distributed, or if the distribution have a tendency to be either axial or girdle type. The test is based on the normalized maximum Eigen value (test against an axial distribution) or minimum Eigen value (test against a girdle distribution). Critical values given in Fisher et al, 1987

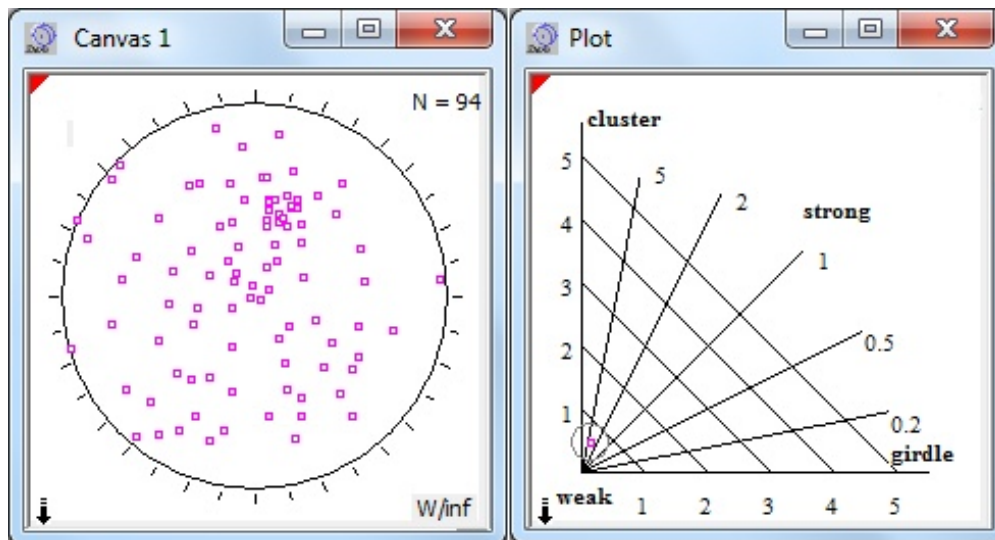


Fig. 35 Eigen values analysis - 1 - An uniform distribution ?

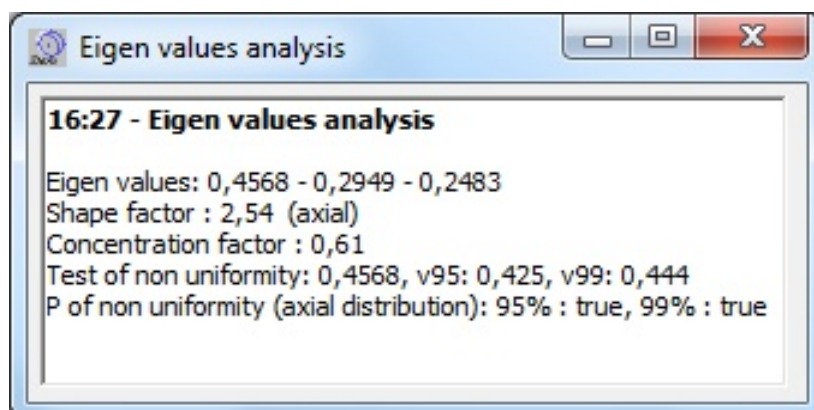


Fig. 36 Eigen values analysis - 2

The parameters and the test results are given in a new text window. You can copy or save its content.

Shape and strength (concentration) parameters

Shape and strength (or : concentration) parameters are functions of the normalized eigenvalues 1, 2 and 3 of the orientation matrix. The strength parameter  $\ln(1/3)$  is labeled from 1 to 5 on the vertical and horizontal axis (figure 1 left), the shape parameter  $\ln(1/2) / \ln(2/3)$  is labeled from 0.2 to 5 on the radial axis. The shape parameter discriminates girdle type distributions (below the line  $= 1$ ) from axial or clustered distributions (above the line  $= 1$ ). Uniform distribution have a very low (ideally 0) strength parameter and plot close to the origin.

More than 1 set of data

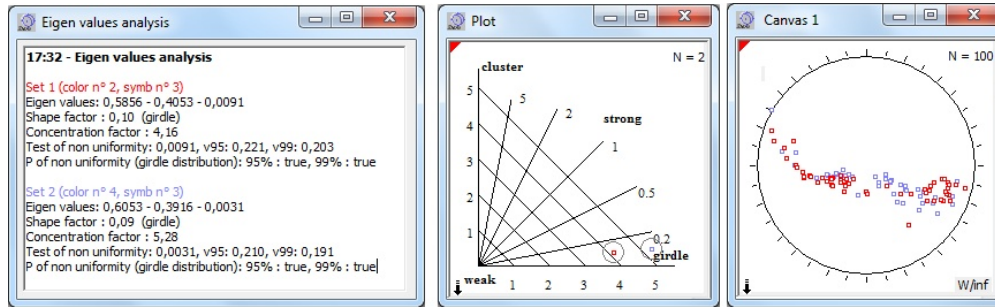


Fig. 37 Eigen values analysis - 3 - Two sets of data, strong girdle distribution

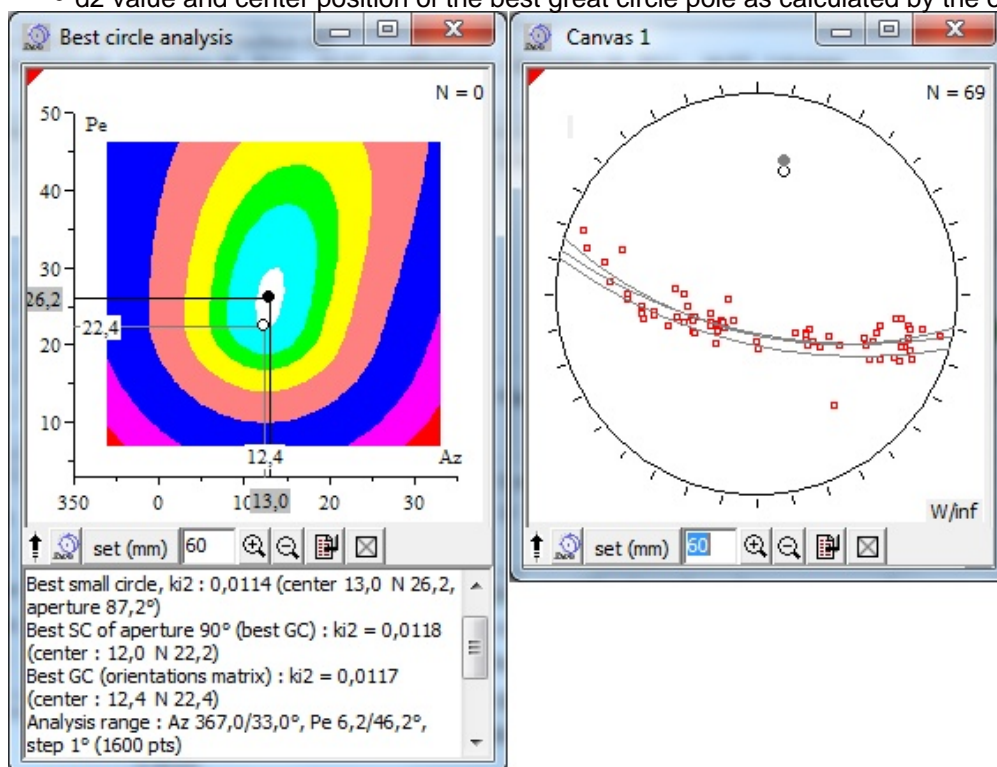
If several sets of data are plotted in the canvas with different symbols, you can either group the values together, or separate the different sets, as in the given example (the “[select symbols](#)” dialog will let you select the sets to be kept). Symbols in the Eigen values diagram are the same as in the canvas.

## Best circle distribution analysis

To test a girdle distribution : great circle (cylindrical) versus small circle (conical)  
 A tool to estimate the strength of the girdle fabric and girdle axis position. Starting from the axis position which minimizes the sum of the squared distances between the circle and the poles (the axis of the best small circle, which can actually be a quasi-great circle), the same calculation for  $d_2$  is made for all the axis positions in a range of  $Az \pm x^\circ$  and  $Pl \pm x^\circ$  around this position. The diagram shows the iso-values contours of  $d_2$ .

Results are:

- position and aperture of the small circle for which  $d_2$  is minimal (it must be the initially calculated best small circle)
- an azimuth/plunge diagram which shows the distribution of  $d_2$  (color scale, see the info part of the window). It gives an idea of the strength of the small circle determination, as compared to a classical girdle distribution (best great circle)
- $d_2$  value and center position for a cone of half-aperture =  $90^\circ$  (the equivalent of a best great circle).
- $d_2$  value and center position of the best great circle pole as calculated by the orientation matrix



Given example : stratifications have been measured across a kilometeric-scale fold. In the field, this fold was considered as a conical fold. Analysis shows that it is actually a small circle which better fit the pole distribution, but this small circle is not significantly different from a great circle. It can be seen

also from the graph that the given measurements allow a rather good estimation of the azimuth of the fold axis, but its plunge is more poorly defined.

## Error on great circle (bootstrap)

A boot strap method to estimate the error on the best great circle (error on the position of the center)

Method : starting from the initial set of X data, N new sets of X data are randomly created. For each of those N sets, the best great circle is calculated, and the sum of the squared distance ( $d_2$ ) between the corresponding great circle and the points is calculated. The results are given in an azimuth - plunge diagram (az and pl of the axis of the N calculated best great circles).

Results are sorted in ascending order of  $d_2$  values. An estimation of the confidence cones 99% and 95% is given by the angular distances ranked 99 and 95% of the list. Color of the dots in the Az – Pl diagram is function of their rank (normed to 100) in the  $d_2$  sorted list : less than 67 (fuschia), 95 (teal), 99 (lime), 99 to 100 (yellow)

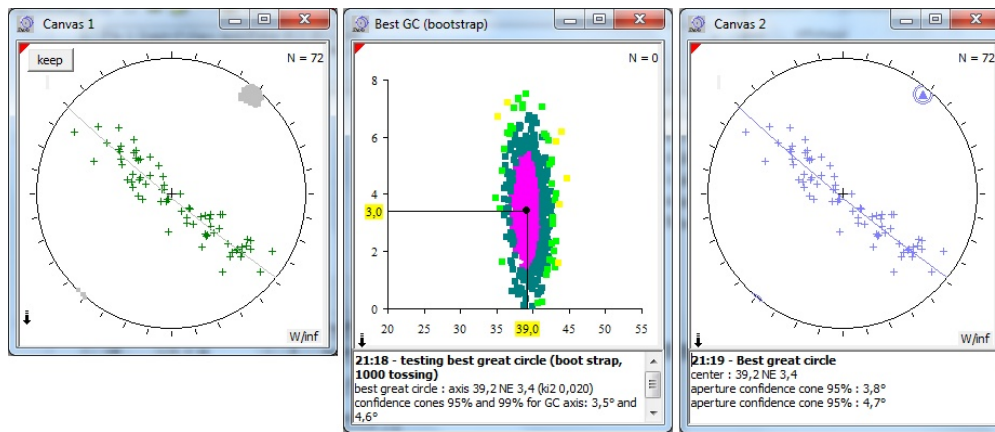


Fig. 38 Boot strap tossing : error on a best great circle

In the given example, estimation of the confidence cone as given by the boot-strap method (above, 1000 tossings) or as calculated from the orientations matrix are very similar : 3.5 and 4.6° (boot-strap), 3.8 and 4.7° (orientations matrix). In gray color (left canvas) : positions of the best great circle axis for each of the 1000 tossings.

Underline in yellow : Az and Pl of the axis position corresponding to  $d_2$  minimum. It can be slightly different from the best great circle axis deduced from the orientation matrix.



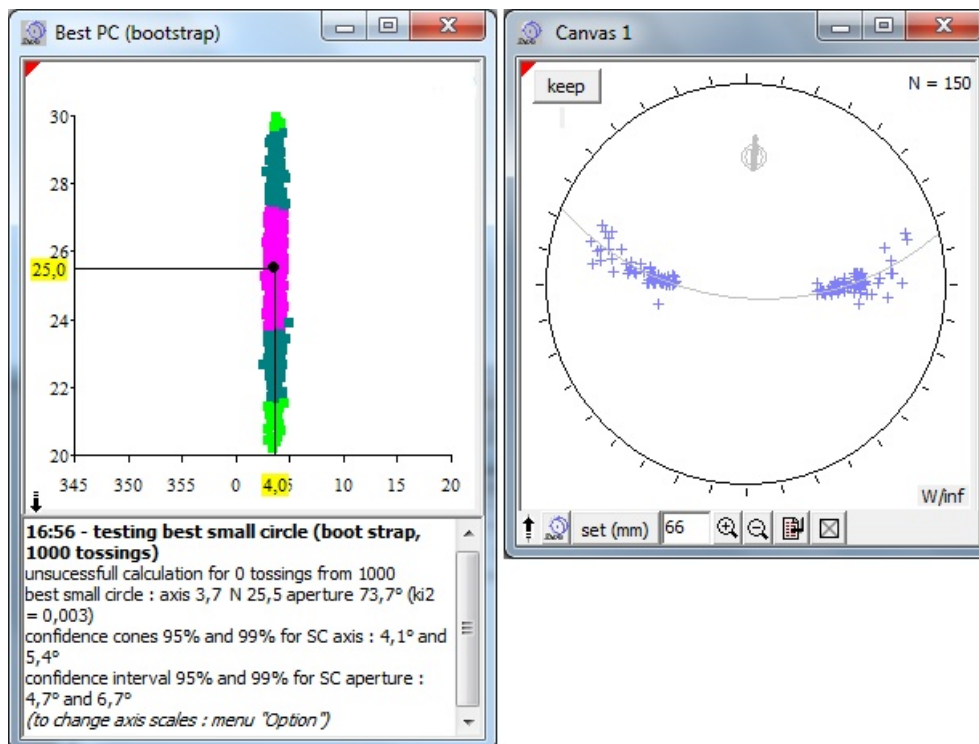
## Error on small circle (bootstrap)

A boot strap method to estimate the error on the best small circle (error on the position of the center)

Method : starting from the initial set of X data, N new sets of X data are randomly created. For each of those N sets, the best small circle is calculated, and the sum of the squared distance ( $d_{2i}$ ) between the corresponding small circle and the points is calculated. The results are given in an azimuth - plunge diagram (az and pl of the axis of the N calculated small circles, each center being also plotted as a grey point in the canvas).

Results are sorted in ascending order of  $d_2$  values. An estimation of the confidence cones 99% and 95% is given by the angular distances ranked 99 and 95% in the list (one tail error). Color of the dots in the Az – Pl diagram is function of their rank (normed to 100) in the  $d_2$  sorted list : less than 67 (fuschia), 95 (Teal), 99 (lime), 99 to 100 (yellow)

Results are then sorted in ascending order of small circle aperture values. An estimation of the confidence angle is given by the difference between the aperture ranked 2,5% and 97,5 % (95% interval) or 0,05% and 99,5% (99% interval, two tails error).



In the given exemple, it can be seen from the graph that the estimation of the azimuth of the small circle best fitting the data is very good (in a range of 2°, whatever the level of confidence), while its plunge is only poorly defined (position in a range of 8° for 95% level of confidence).

## Test rotational symmetry

To test the rotational symmetry of a set of points : graphical analysis and Kuiper's statistic

To estimate visually if a set of data could have a rotational symmetry, a rotation is applied to the set to bring its best axis at the center of the canvas.

If there are several sets of data plotted in the canvas (i.e. data with different symbols), the “[select symbols](#)” dialog is first displayed to select the sets to keep.

A second dialog will ask you if the selected data belong rather to an axial or a girdle type distribution. A default choice is given, based on the shape parameter (as given by [Eigen values](#)).

If it is a girdle distribution, the rotation brings the axis of the best great circle to the center of the canvas. If it is an axial (bimodal) distribution, the rotation brings the best axis to the center of the canvas.

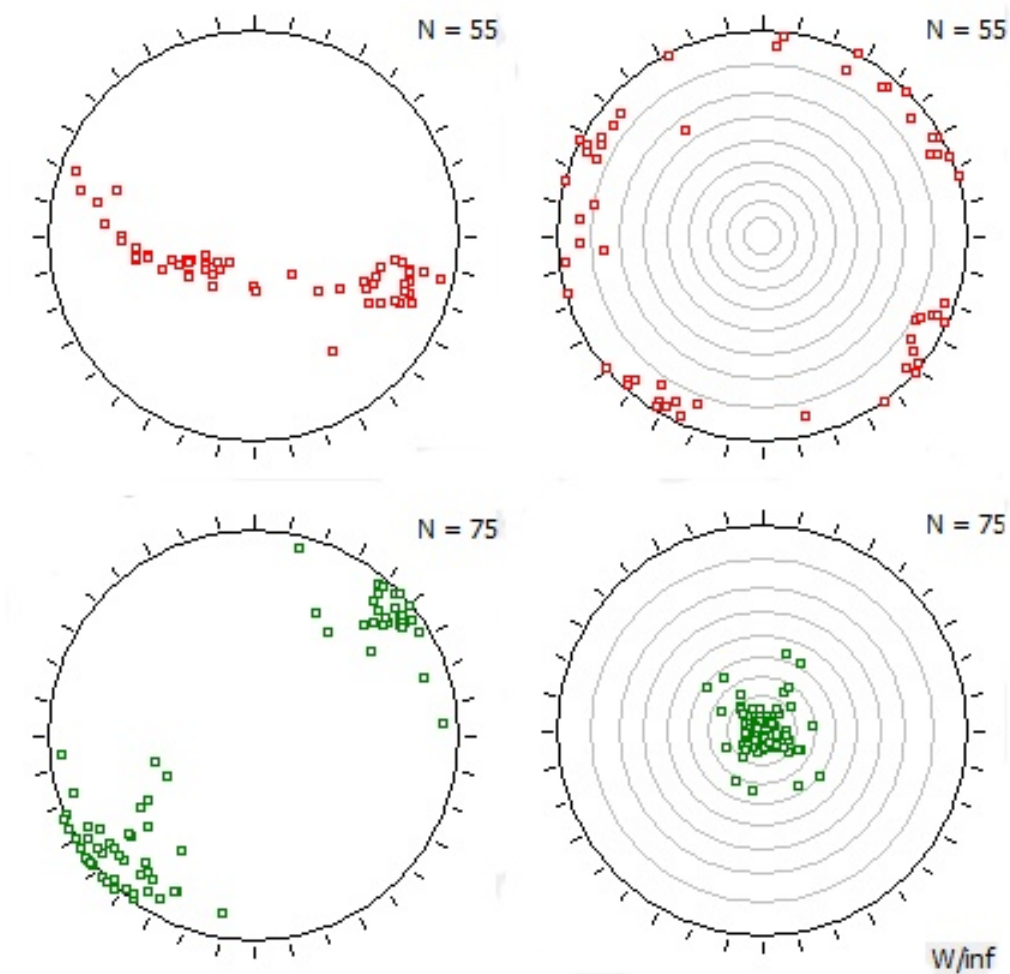


Fig. 39 Shifting best axis to center

## Graphical analysis

If it is a girdle distribution, rotational symmetry is plausible if the rotated poles are regularly distributed along the canvas circumference. If it is an uniaxial (bi-modal) distribution, the poles should draw a homogeneous cloud around the center of the canvas.

## Formal test

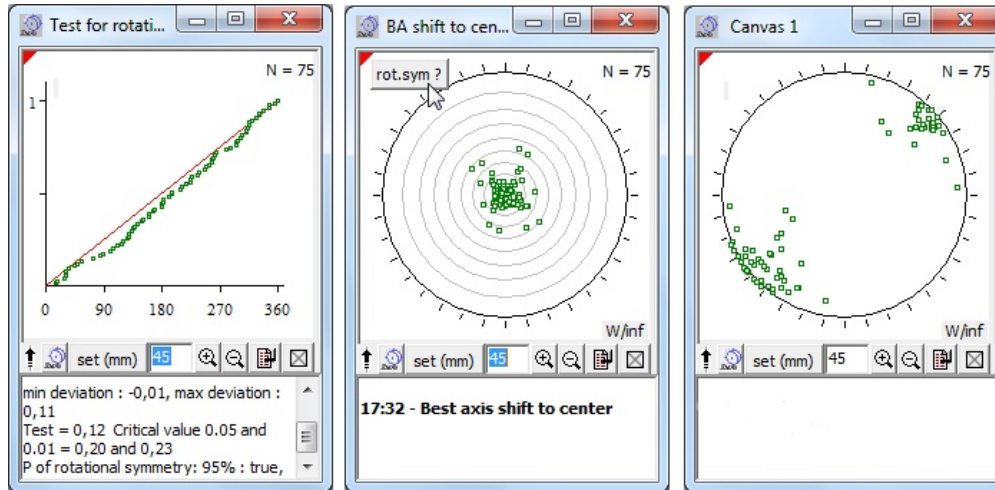


Fig. 40 Best axis shifted to center, Q-Q plot and kuiper's statistic

Click on the button “ Rot. Sym” to display in a new window a Q-Q plot (quantile - quantile plot) : azimuth sorted from 0 to 360° are plotted against the quantile of the uniform distribution  $U_i$  ( $U_i = (i-1/2)/N$ ,  $i$  being the rang of the value,  $N$  the total number of values). Assumption of symmetry is implausible if the plot is not approximately linear, passing both through the origin and the ( $U_i = 1$ ,  $az = 360^\circ$ ) point.

A formal test is provided calculating for the shifted azimuths the Kuiper's statistic. Critical value is the sum of the maximum positive and maximum negative discrepancies between the actual positions of the points and the straight line (theoretical uniform distribution). Critical values given in Fisher et al., 1987. In the given example, test is positive, and we can assume a Watson distribution.

## Watson distribution analysis

To test the goodness-of-fit of the Watson bipolar model

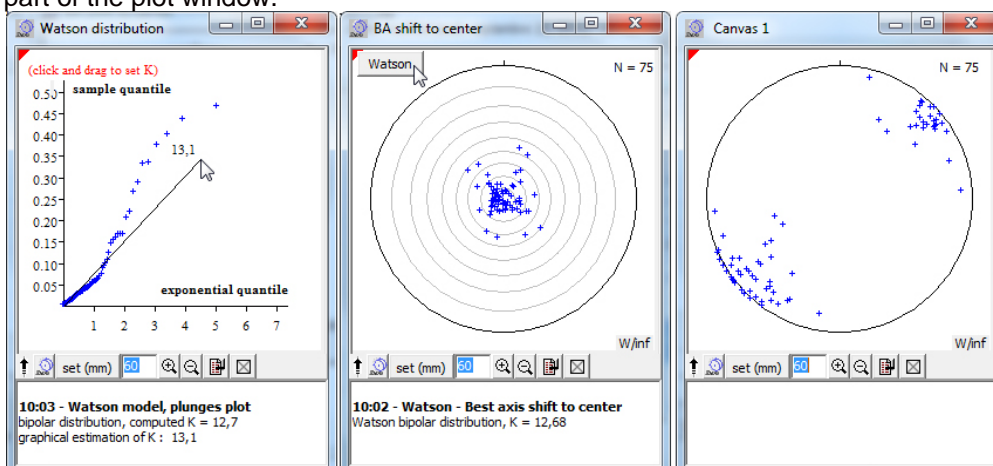
Watson distribution is the basic model for undirected lines (axes) distributed with rotational symmetry in either bipolar (uniaxial) or girdle form. There are 3 parameters : Az and PI, which define the position of the symmetry axis, and K, the shape parameter, which is positive for a bipolar distribution and negative for a girdle distribution. The larger the absolute value of K, more the distribution is concentrated around the best axis (bipolar distribution) or close to the great circle (girdle distribution).

Assumption of the plausibility of a Watson distribution is made graphically. It is a multi-steps process (see Fisher et al, 1987) :

1. test for rotational symmetry around the best axis. Data are rotated to set the main axis at the center of the canvas. If points draw a rather uniform cloud around the center (for an axial distribution), or are dispersed all around the canvas circumference (for a girdle distribution), rotational symmetry can be assumed. If doubtful, it can be more formally tested using the [Kuiper's statistic](#) (Q-Q azimuths plot),

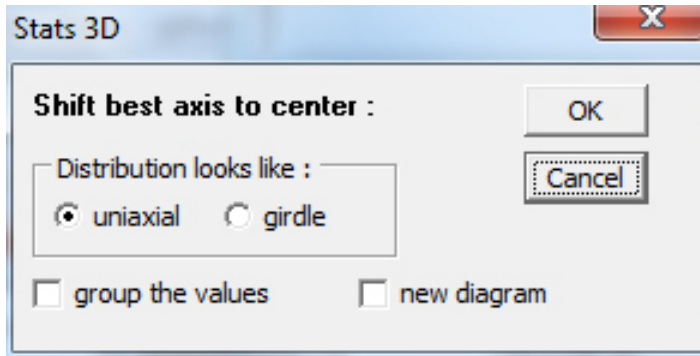
2. drawing of the Q-Qexp (quantile-exponential quantile) plot of the plunges (actually of the coplunge =  $90^\circ$  - plunge). Watson distribution follows an exponential model, and the Q-Qexp plot should be approximately linear, passing through the origin. The slope of the plot gives an estimate of the parameter K of the Watson distribution. Such diagram also allows the detection of "outlier" data, which will be suspiciously far from the main data mass.

3. Assuming a Watson distribution, estimation of the concentration parameter K can also be directly computed from the Eigen values of the orientation matrix. This estimation is given in the info part of the plot window.



Stem follows this multi-steps process :

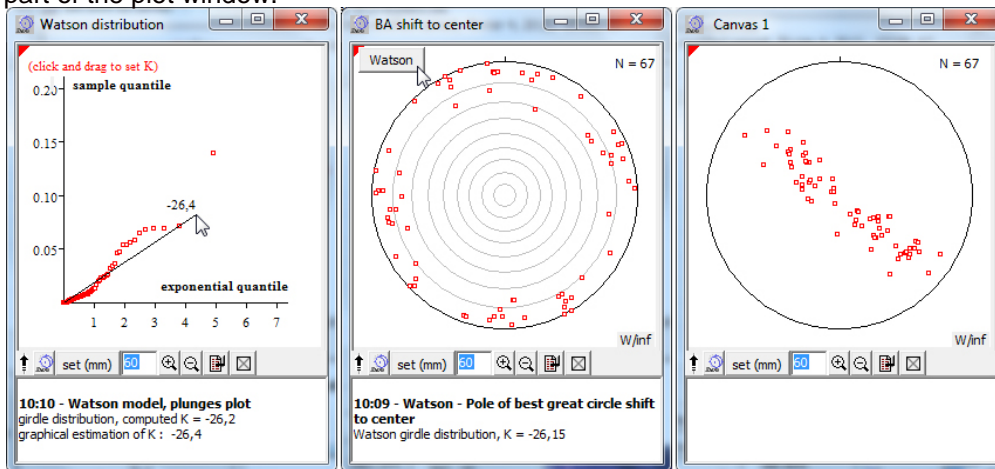
If there are several sets of data plotted in the canvas (i.e. data with different symbols), the “[select symbols](#)” dialog is first displayed to select the sets to keep.



A second dialog (above) will ask you if the selected data belong rather to an axial or a girdle type distribution. A default choice is given, based on the shape parameter (as given by [Eigen values](#)).

1. A new canvas is drawn, with the rotated poles. If it is a girdle distribution, the rotation brings the axis of the best great circle to the center of the canvas. If it is an axial (bimodal) distribution, the rotation brings the best axis to the center of the canvas.

2. Click on the “Watson” button to display the Q-Qexp diagram. In this diagram, you can adjust a straight line through the set of points, clicking in the canvas and dragging the mouse. In the same time, you can follow the estimated K value (inverse of the slope of the line), displayed too in the diagram. The computed value of K (from the Eigen values of the orientation matrix) is given in the info part of the plot window.



## Outlier test

Test for outliers, assuming a Watson distribution

*Unimplemented in this version*

## Trackdip

### Multi-scale processing of dipmeter data

Trackdip is a recent method to process bedding attitudes from outcrops in order to identify at various scales the successive changes of orientations in a sedimentary section<sup>1</sup>. It can be used to process dipmeter logging data or outcrop exposures.

The data set consists of a series of measurements and dip angles of stratigraphic bedding surfaces. Processing is based on a multi-spectral analysis, where the changes of bedding attitude are compared and tracked between various scales.

A given scale defines a window size. For the given scale, the data set is cut in successive windows. A best plane is computed for each window, then a change of attitude (tilt) is calculated between two successive and adjacent windows. Computing the tilts between all the adjacent windows for all investigation scales results in matrixes of rotation axis, rotation angles and tilts ways as a function of depth and window size. It is a process that identifies the most significant tilts in these matrixes.

The data

	nat	val	num	loc	com
181	s0	161,1 W 15,1	181	191,41	
182	s0	117,9 SW 18,8	182	191,68	
183	s0	156,6 SW 16,3	183	191,96	
184	s0	114,9 SW 11,0	184	192,24	
185	s0	175,0 W 10,8	185	192,34	
186	s0	141,4 SW 17,6	186	192,42	

Data must be imported to a specific Stem file from the output text file provided by the dipmeter (see [Import](#)). Stem add a default nature code ("s0") and a default number code (the line number). The depth of measurement is stored in the "Location" column<sup>2</sup>.

### Proceeding the data

The significant events are tracked from the largest to the smallest window size, searching rotations characterized by significant rotation angles (larger than a fixed cut-off angle, for instance 3°), similar axis trend and similar tilt way. Trends are consider to be similar if there angle is smaller than a cut-off angle, f.i. 20°. Cut-off values can be modified in the "Options" menu, sheet "Stats-2".

### Results

Numerical results of the analysis are given in two windows

**The trackdip window**, which lists the significant rotations. Each lines gives :



787	6.310	105.523	6	111.7	S 15.1	16	112.9	SW 12.8	2.3	104.8	W 1.8	194.6
788	6.310	118.142	14	113.9	SW 13.8	8	138.5	SW 10.7	6.0	67.4	SW 10.1	156.6
789	7.943	121.889	14	114.6	SW 12.9	15	149.4	SW 11.2	7.3	55.4	SW 11.1	144.8
790	10.000	119.690	21	113.1	SW 13.8	18	145.7	SW 10.8	7.5	62.7	SW 10.7	151.9
791	12.589	111.922	22	112.5	SW 13.4	22	121.3	SW 12.5	2.2	53.3	SW 11.6	142.6
792	12.589	124.511	22	121.3	SW 12.5	23	146.1	SW 11.6	5.2	53.0	SW 11.6	142.6
793	15.849	110.068	17	112.5	SW 13.1	30	121.5	SW 12.8	2.0	36.0	SW 12.7	125.6
794	15.849	125.917	30	121.5	SW 12.8	33	149.7	SW 11.9	6.0	53.5	SW 11.9	143.0
795	19.953	119.761	37	112.7	SW 13.6	33	146.7	SW 11.5	7.5	55.9	SW 11.5	144.8
796	25.119	124.571	44	116.7	SW 12.9	49	146.4	SW 12.0	6.4	49.5	SW 11.9	139.0
797	31.623	118.067	36	113.1	SW 13.6	57	145.4	SW 11.8	7.2	53.1	SW 11.8	142.4
798	39.811	129.785	55	121.7	SW 12.3	74	145.4	SW 11.9	4.9	48.3	SW 11.8	138.0
799	50.119	149.690	93	131.9	SW 12.0	106	144.4	SW 11.5	2.6	61.3	SW 11.4	150.9

- a raw number, to which Stem can further refers to;
- the size of the window (list sorted by increasing window size), in the same unit as depth;
- the depth of the boundary between the 2 selected windows
- the number of measurements and the best orientation first for the upper window w1, then for the lower window w2
- the angle between the two computed best orientations for data of w1 and w2, and the rotation axis between them.
- the new azimuth of the rotation axis after a new rotation which bring the w2 best plane to an horizontal position. This angle is used to test the similarity of sens of rotation between two successive tests.

**The polygons windows.** It lists the series of successive compatible boundaries between two windows from large window size to smaller window size. A continuous succession of compatible boundaries define a polygon, each nod being defined by its depth (depth of the limit between the two tested windows) and the window size. Polygon are listed only if they are made of a number of segments larger than a cut-off value (fixed too in the Option menu : polygon minimum size).

polygone n° 1												
799	50.119	149.690	93	131.9	SW 12.0	106	144.4	SW 11.5				
798	39.811	129.785	55	121.7	SW 12.3	74	145.4	SW 11.9				
797	31.623	118.067	36	113.1	SW 13.6	57	145.4	SW 11.8				
796	25.119	124.571	44	116.7	SW 12.9	49	146.4	SW 12.0				
795	19.953	119.761	37	112.7	SW 13.6	33	146.7	SW 11.5				
794	15.849	125.917	30	121.5	SW 12.8	33	149.7	SW 11.9				
792	12.589	124.511	22	121.3	SW 12.5	23	146.1	SW 11.6				
790	10.000	119.690	21	113.1	SW 13.8	18	145.7	SW 10.8				
789	7.943	121.889	14	114.6	SW 12.9	15	149.4	SW 11.2				
788	6.310	118.142	14	113.9	SW 13.8	8	138.5	SW 10.7				
785	5.012	119.619	9	111.9	S 14.0	7	145.2	SW 10.8				
779	3.981	119.832	7	112.2	S 14.3	5	139.1	SW 9.9				
768	3.162	119.648	6	109.8	S 14.0	3	124.1	SW 9.8				
polygone n° 2												
795	19.953	119.761	37	112.7	SW 13.6	33	146.7	SW 11.5				
793	15.849	110.068	17	112.5	SW 13.1	30	121.5	SW 12.8				
791	12.589	111.922	22	112.5	SW 13.4	22	121.3	SW 12.5				

### Graphical analysis

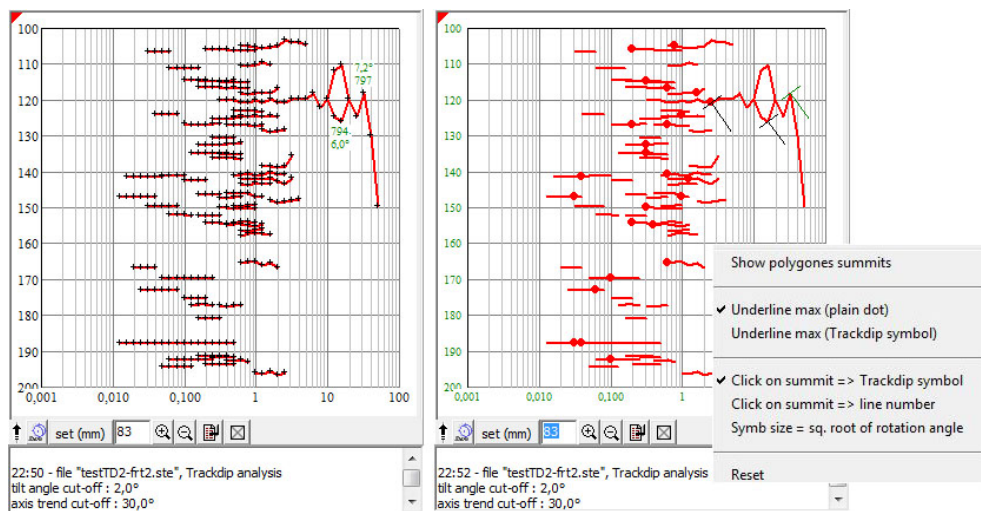
The previously defined polygons are drawn in a semi-logarithmic graph (depth of a nod v. size of the window).

Click with the right button of the mouse to display a pop-up menu with specific Trackdip drawing options :

- To underline by a small black symbol the position of the polygons summits.
- To underline the nod of the polygon with the maximum rotation. The nod is marked either as a plain dot, or with a specific symbol, looking like a dip symbol (a T). Orientation of the T bar is parallel to the trend of the rotation axis, and length of the T bar is proportional to the rotation angle (or, on choice, to



the square root of the rotation angle).



To re-identify any of the polygons summits: left click on it. A summit can be identified either by its number in the Trackdip window (rotation and depth then reported in the info part of the plot window), or by a specific T symbol (shift from one style to the other using the pop-up menu). When you use the option "Summit identified by line number", and press down the shift key, both the line number and the rotation angle value are displayed.

#### Display rotation axis

If you select this option (menu [Options, Stats-2](#)), rotation axis are displayed in a new datasheet.

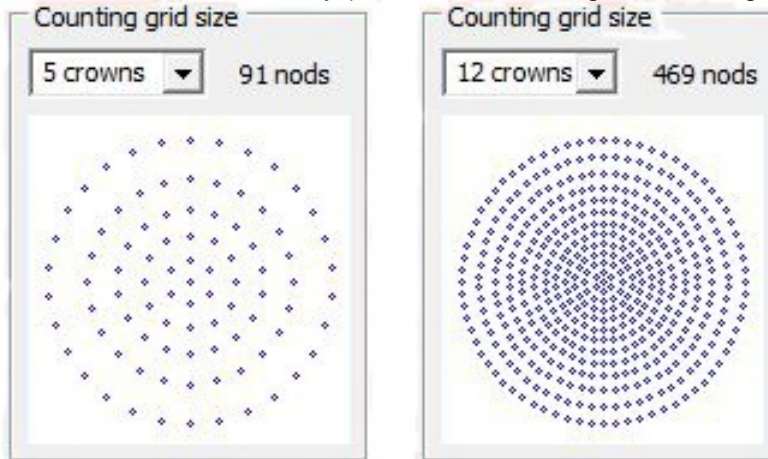
1 C. Basile, A. Pêcher, M. Corazzi, F. Odonne, A. Maillard, E.J. debroas, P. Callot (2009) - Marine and petroleum geology, 26, 738-751

2 Caution : check your file, as in a previous version of Trackdip deep was stored in the "Comment" column. To modify such a previous Stem Trackdip file, export it as text, then re-import it in the right way (see [Options, sheet Import](#))

## Counting

### Counting

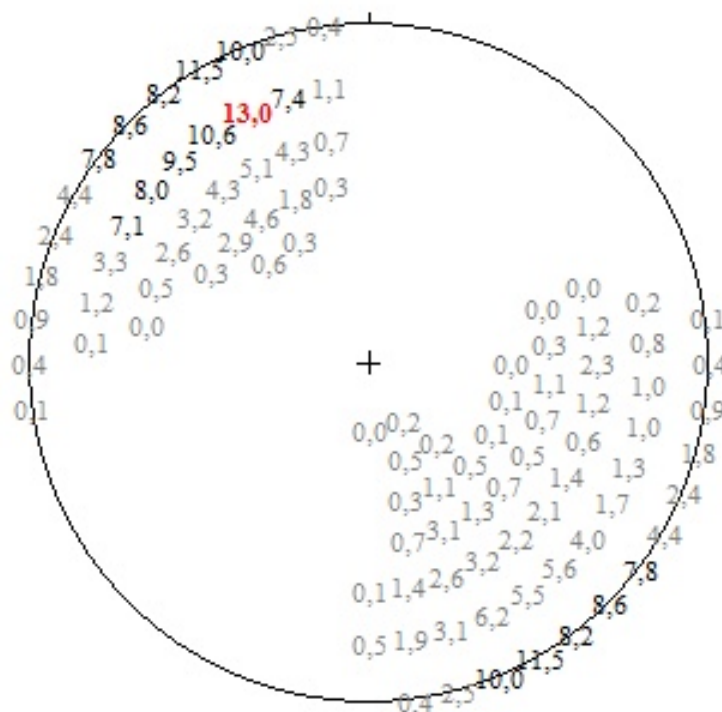
Measurements of the density (number of axis in a given counting cone) at the nodes of a regular grid



The counting grids have a hexagonal symmetry, the number of nodes depends on the number of concentric crowns in the grid (from 5 crowns/91 nodes to 12 crowns/469 nodes). The half-aperture of the counting cone ranges from  $12^\circ$  (5 crowns grid) to  $5^\circ$  (12 crowns grid). Accordingly, a low number of crowns smooths much more the irregularities of the distribution than a high number of crowns.

Density data are displayed in a canvas (Wulff or Schmidt net), either as raw values (number of data at each node in the counting cone) or as multiples of uniformity (uniformity : same number of data at each node in the case of a homogeneous distribution). To choose the number of crowns and the display type, see [Options](#), page Stats-1.

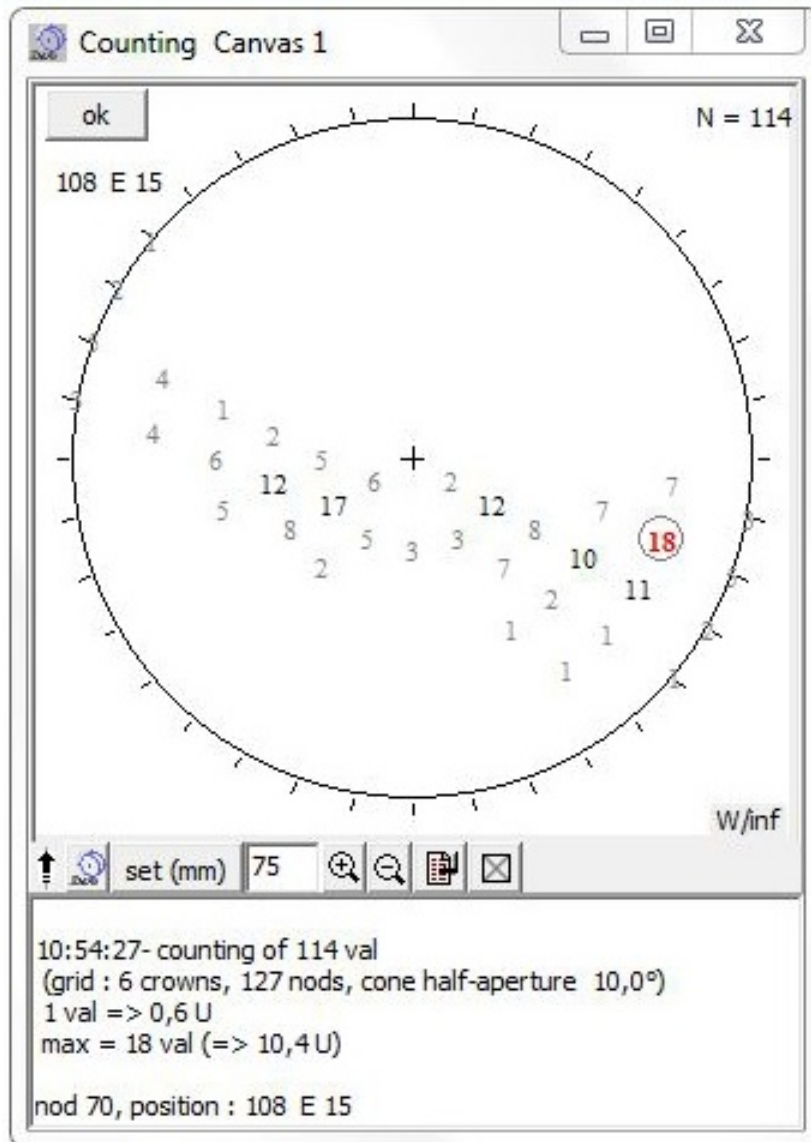
If the data stereonet contains more than one symbol, the “[select dialog](#)” allows the selection of the symbols to keep in the counting.



Density values (either raw values, or factors of uniformity as in given example) are displayed in red color (maximum value), black color (value > 0.5 maximum) or gray color (value < 0.5 maximum)

## Counting : nod position

Position of a nod of the counting grid



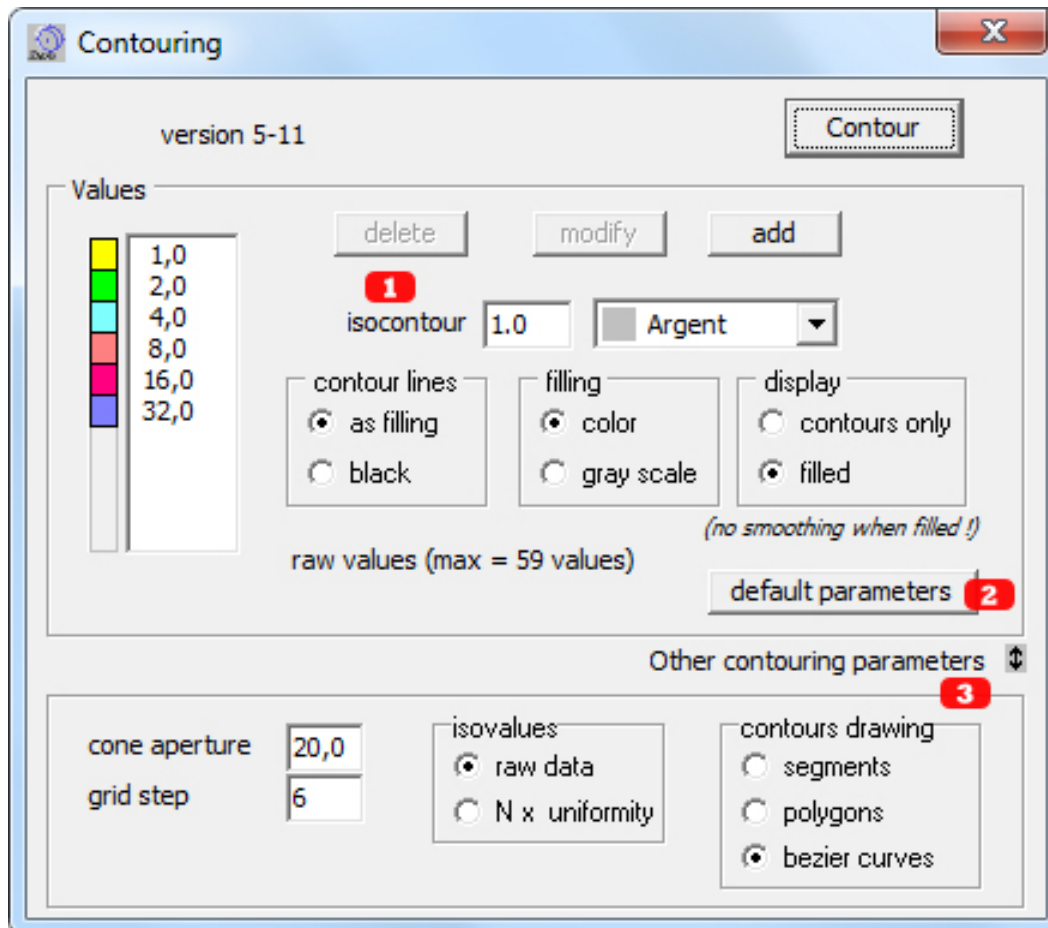
To get the position of the nod, in the given example the nod bearing the maximum value (in red). The [counting parameters](#) are given in the info part of the window.

To select the nod : click on it, then the closest nod is underlined by a plain circle, its position is given both below the button OK and in the bottom info part.

## Contouring

### Displaying isodensity contours for a set of data

Density values are first calculated at the nodes of a new rectangular grid (different from the grid used in the Counting function, which has a hexagonal symmetry). Mesh of the new rectangular grid can be changed to get more or less smoothed contours. Minimum mesh size is 5.



A dialog let you fix the contouring and drawing options.

### Main options :

- **1** Isocontour : to fix the values of the isodensity curves, and the color (or gray density) attributed to each value. To add an isocontour : button "add"; the new value is inserted in the values list. To delete or modify an isocontour : select it in the value list, then use buttons "delete" or "modify". To select or modify a color, use the drop down list of colors (predefined Window's colors, or a personalized color when clicking in the first item of the list). To select various gray colors, modify the gray percentage.

- Display : you can draw only the contour line itself, or paint the area inbound the contour.
- Filling : to shift between color drawing or gray drawing.
- Contour lines: contour lines drawn in black, or using the selected colors (or gray level).

- **2** Default parameters : to get a suggestion for curves levels (given values are dependent on the maximum density) and colors. To change the whole set of default colors, go to menu Options.

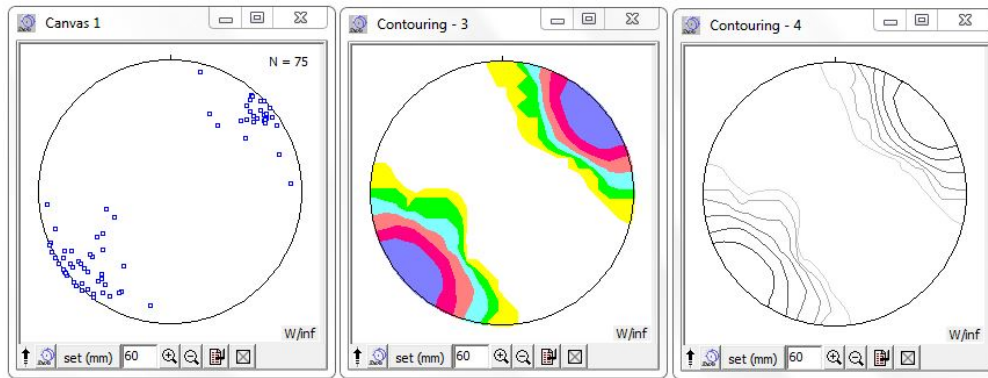
**Additional options** (**3** lower part of the dialog. The dialog window can be folded or unfolded using the small double arrow at the right):

- Cone aperture and grid mesh : larger are the cone aperture and the grid mesh, more smoothed are the contour lines. As contouring is in any case a non-neutral and biased tool to present the data, and as calculation is fast, you can do several tries to test which combination of values give the most demonstrative result. The default values suggested seem to be a good compromise.

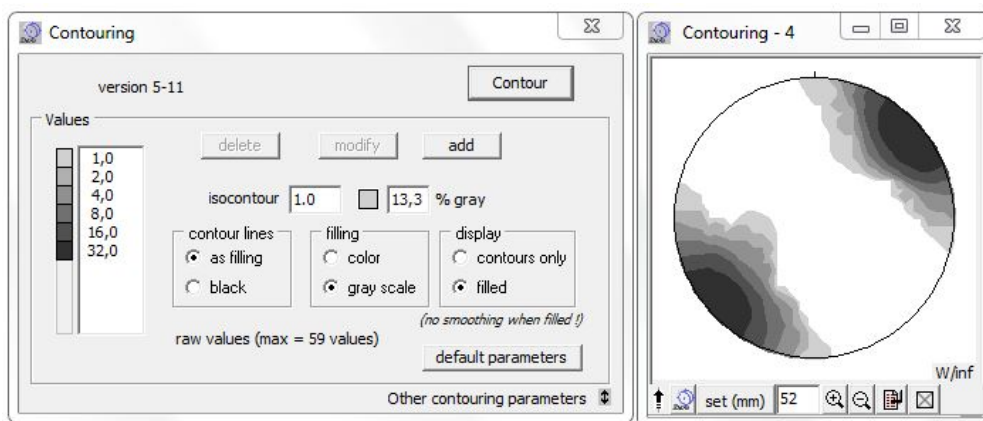
- - Isovalues : density value at a given nod given either as number of data in the counting cone ("raw data"), or normalized to the uniform distribution.

- - Contours drawing : each contour is actually a succession of segments, each segment joining 2 sides of each cell of the counting grid. The faster way to draw the contours is to draw each segment, with the option "contour line : as filling" set on. But if you want to improve the contouring aspect using a drawing soft (which can be done if you save the canvas as an \*.emf file), it will be hard to do. A better solution, even if slightly more time consuming, is to combine these segments in a polygon (in a drawing soft, it will be then considered as a single object, instead of N segments). It is also possible to transform the polygon in a smoothed Bezier curve. This last option is the best one if you want to display only the contours lines, but cannot be used in Stem if you want to paint the inbound area (if so, the contour lines will be drawn as unsmoothed polygons).

### Example of contouring



Above, from left to right : the set of data; unsmoothed filled contours (raw data); unfilled smoothed contours (Bezier's curves), gray scale. Below : same data, mesh 6 instead of 7.



## Display best fits

### Managing calculated or visually estimated best-fits

All calculated or estimated best-fit values are kept in a specific table attached to the canvas, together with some other statistical results (f.i. estimation of the confidence cones for the position of a calculated best axis).

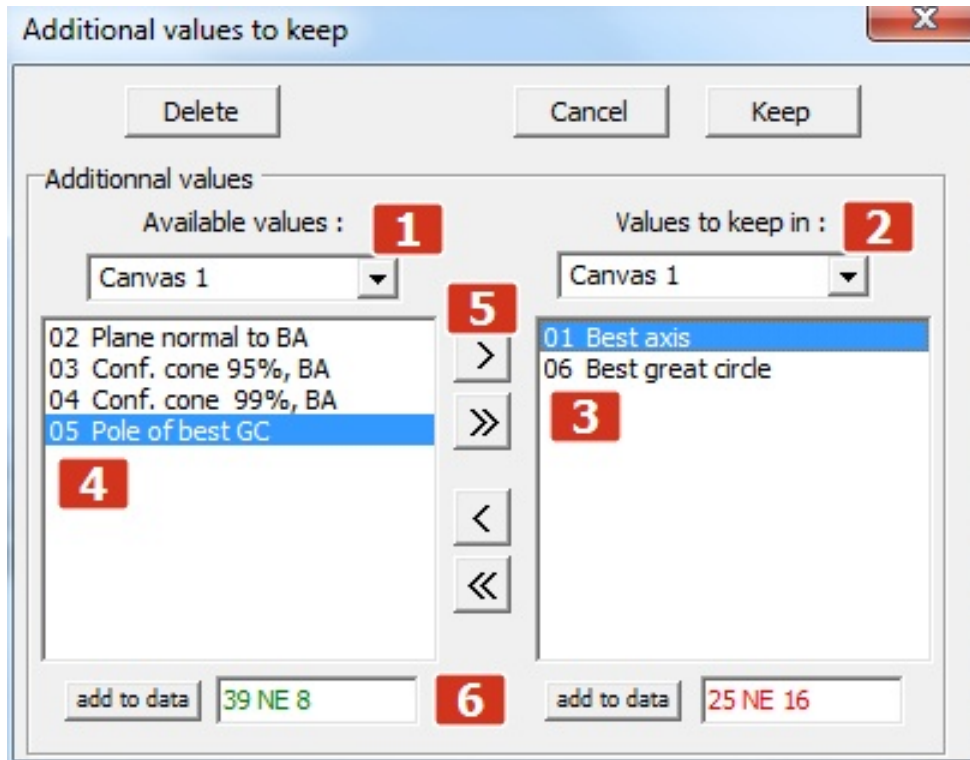


Fig. 42 Best-fits dialog

1. Best-fits calculated from data plotted in this canvas
2. Canvas where to display the selected best-fits (most of the time, both canvas are the same)
3. Best-fits already plotted in the selected canvas
4. Values available but not plotted in the selected canvas
5. To shift the data from one list to the other one (simple arrow : the selectionned value; double arrow : all the listed values)
6. The selected value can be added in the canvas as a standard data

The display best-fits dialog lets you

- display or hide in the active canvas any additional value previously obtained (visible or not in the canvas)
- add to another canvas extra values calculated from the data displayed in the currently active canvas
- add to the table of data attached to the active window any of the calculated best fits.



## Values listed in the best-fit dialog

### Calculated best-fits

- Best pole, 95% and 99% confidence cones, plane corresponding to the best pole
- Best great circle, and 95% and 99% confidence cones, pole of the great circle
- Best small circle
- Best clusters
- Best circle distribution analysis
- Best great circle (boot strap), 95% and 99% confidence cones
- Best small circle (boot strap), 95% and 99% confidence cones

### Visually estimated best-fits

- Great circle (mouse tracking)
- Small circle (using a grid)
- Great circle (via 2 points)
- Small circle (via 3 points)

## Menu Stats 2D

Representation of data and statistical functions in 2D

- [Rose diagram](#)
- [Circular histogram](#)
- [Circular plot](#)
- [Linear histogram](#)
- [Kuiper test](#)
- [Von Mises distribution](#)

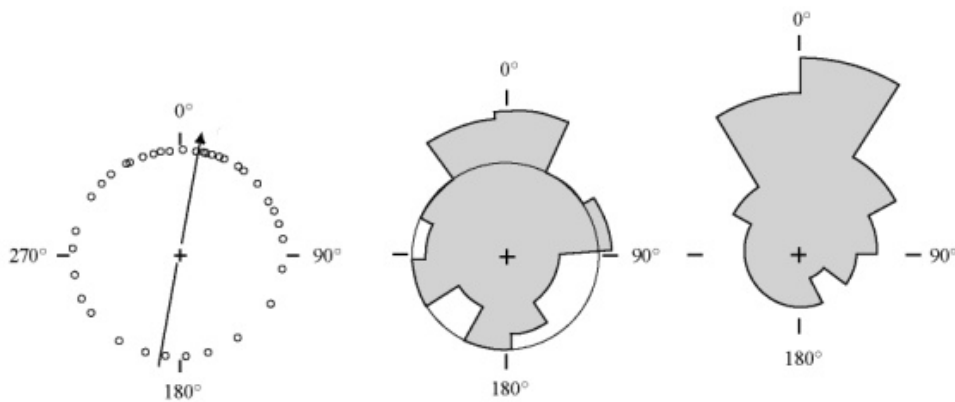
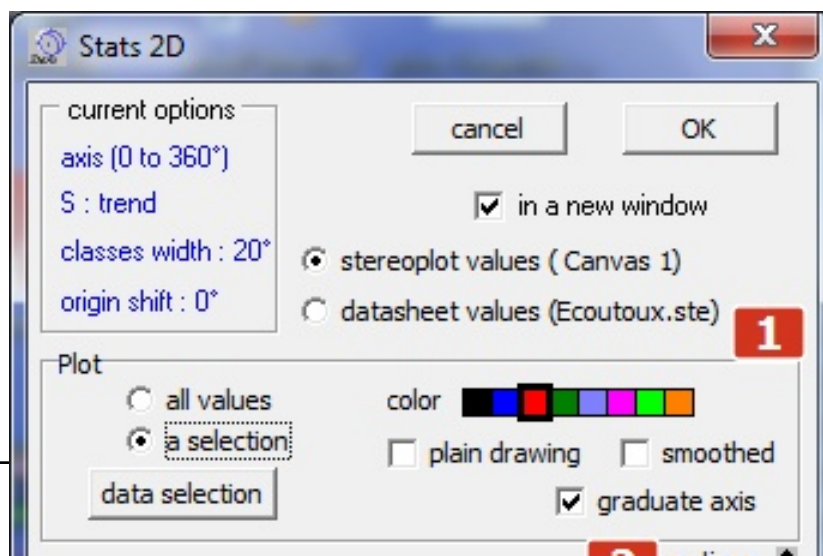


Fig. 43 Circular plot, circular histogram and rose diagram (same data)

First functions of this menu are tools to display the data. Data can be read in a datasheet, or can be already displayed in a canvas. Most of the times, data will be azimuths of 3D measurements, more rarely their dips.

To edit 2D data, use a standard datasheet, and enter the data as lines, with plunges = 0°

When using 2D tools with 3D data, it can be convenient to make the difference between two measurements having the same azimuth, but opposite dips directions : if so, the orientation is equivalent to a vector, azimuth ranging from 0 to 360°. If it isn't useful to consider the dip direction, and if we want to omit it, the direction is now equivalent to an axis, which can be given in the range 0-180° (or 0-360°, each value being completed by the opposite one, to keep a similar presentation for the 2 types of diagrams, vectors or axis).



1. Selection of the data
2. click on the arrow to fold or unfold the lower part of the dialog
3. How the data should be processed
4. Display options

The “ Stats 2D” dialog lets you fix the different options :

- Where are the data (data plotted in a canvas or listed in a datasheet)
- Selection of the data to use, either in the datasheet or in the canvas (click in the “ data selection ” button to display the data selection dialog, see below)
- Orientation of a plane : in 2D, it is a line, which can be the horizontal of the plane (its strike), its dip direction or the direction of its pole.
- A measurement can be considered as a vector or as an axis (see [above](#))
- For an histogram or rose diagram, selection of the class width. You can start the first class at 0°, or shift the class origin. Shifting the origine of the classes can change drastically the aspect of an histogram !
- Drawing of the median and/or the average value.

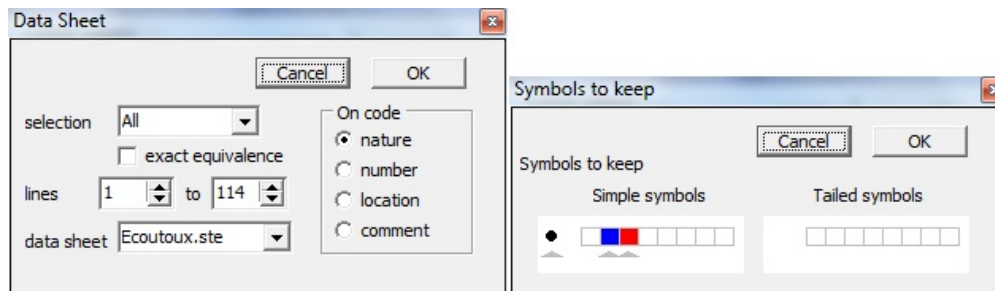


Fig. 45 The 2 sub-dialogs to select the data (from a datasheet, from a canvas)

## Rose diagram

Displaying data in a rose diagram (values grouped by classes)

In rose diagrams and [circular histograms](#), orientations are grouped in classes, each class of values corresponding to one of the petals of a circular diagram.

It is an efficient way to show 2D preferred orientations. In a rose diagram, the lengths of the petals are proportional to the number of values in each class. In a circular histogram, the area of the petals are proportional to the number of values in each class.

In the case of an uniform distribution, the length of each petal is the the same.

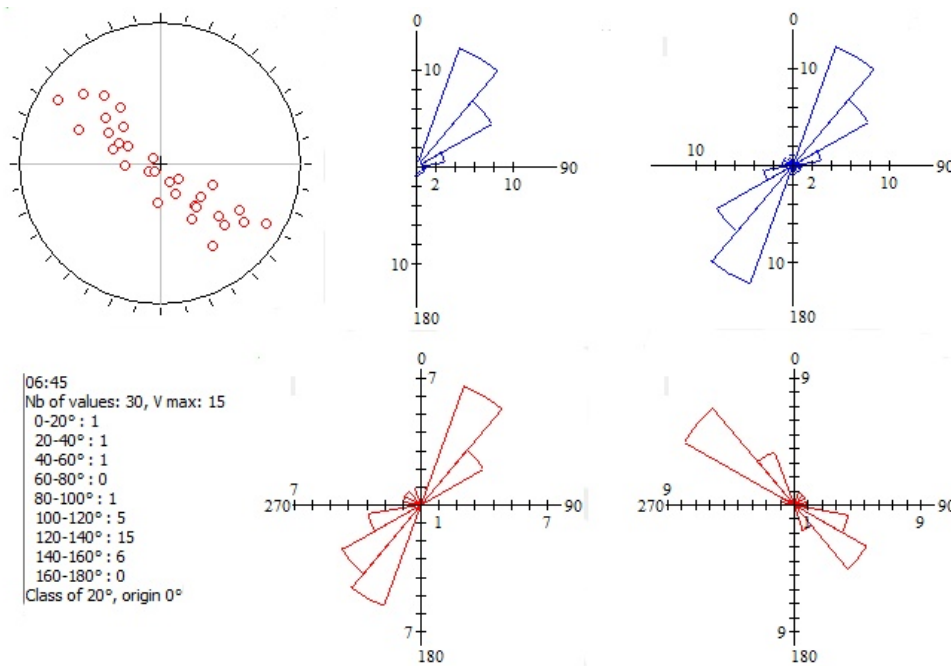


Fig. 46 Different types of rose diagrams


Figure : different rose diagrams for a same set of planes (data from the left canvas). Classes of 10°. Options fixed in the "[Stats 2D](#)" dialog.

- top left : orientations are axis, displayed in a 0-180° diagram (as it can be seen on the canvas, all the planes strike around N45°E)

- top right : same data, displayed in a 0-360° diagram. The previous diagram is completed symmetrically around the center. There is no more information in this diagram than in the previous one

- bottom left : orientations are differentiated according to the sense of dip. The diagram is no more centro-symmetric. It can be seen that more values are dipping NW than SE (the orientation is given using the right hand rule).

- bottom right : same set of data, dip directions. It is now easy to see the difference between NW and SE dipping planes.

By clicking on the  button in the toolbar, the number of values in each class is listed beside the diagram

Note : in a class, the lower bound is included, the upper bound is excluded.

## Circular histogram

Displaying data (values grouped by classes) : circular histogram

Circular histograms are very similar to [rose diagrams](#), and offer the same options, fixed using the [2D Stats](#) dialog. But in circular histogram, it is the area of the petals which are proportional to the number of values in the class, expressed as frequencies (from 0 to 1).

The circle of area 1 is displayed. For an uniform distribution, the radius of each class is the same, and equal to the radius of the circle.

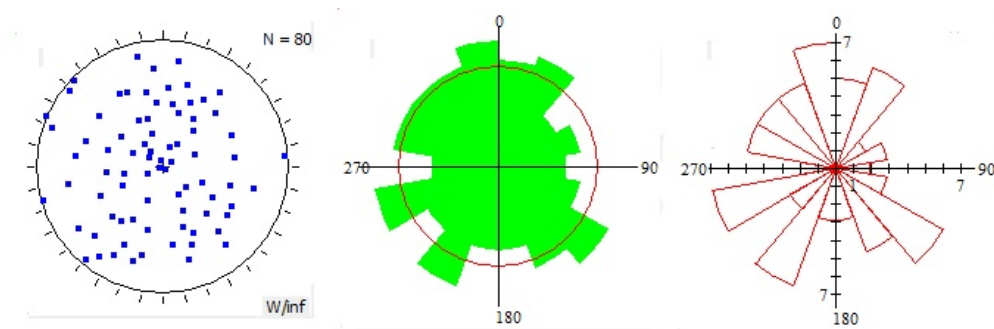


Fig. 47 Circular histogram

Given example : an artificial set of 80 data (left canvas), having a rather uniform distribution. Data displayed in a rose diagram (right) and in a circular histogram (center). As compared to the histogram, the rose diagram overemphasizes the slight non-uniformity of the distribution.

## Circular plot

Displaying data in a circular plot. Circular median, Hodges-Ajne's test of uniformity Orientations are plotted as points on the circumference of a circle.

Such a plot is used to find the circular median (diameter corresponding to an equipartition of the points on both sides).

It can be used too for the non-parametric test of uniformity of Hodges-Ajne : if we locate the diameter such that a minimum number of points ( $m$ ) falls to one side, the value of  $m$  reported to the total number of points tests the non-uniformity.

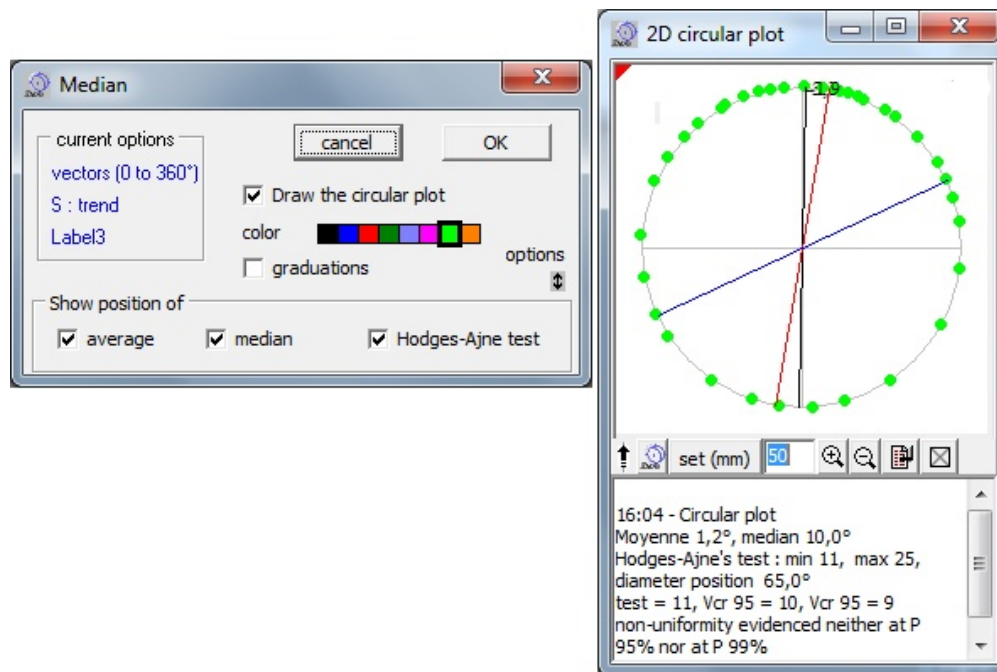


Fig. 48 Circular plot of a set of 36 orientations

Amongst the options given by [2D stats](#) dialogs, some are specific to the circular plot :

- Draw the circular plot : if not ticked, plot is not drawn, but average value, median and Hodges-Ajne's test results are listed in a text window.
- Graduations, to graduate the circular plot (10° subdivisions)
- Average value, median and Hodges-Ajne's test : tick to draw the corresponding diameters on the plot (as in given example)

## Linear histogram

Displaying data (values grouped by classes) : linear histogram

Another way to display the orientations of a set of 2D data.

Linear histograms have the same data and display options as the circular histograms, fixed using the [2D Stats dialog](#).

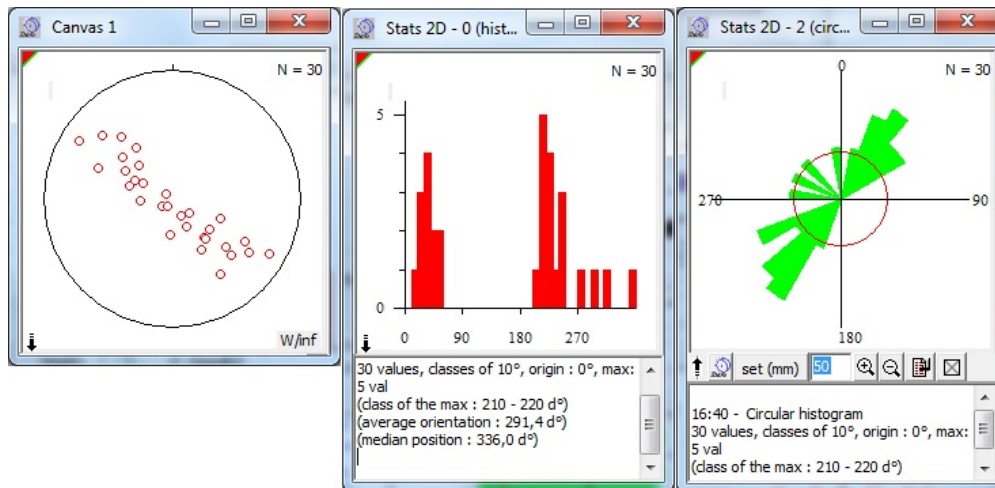


Fig. 49 Linear and circular histograms for a same set of data

Influence of the class limits on the aspect of the histogram

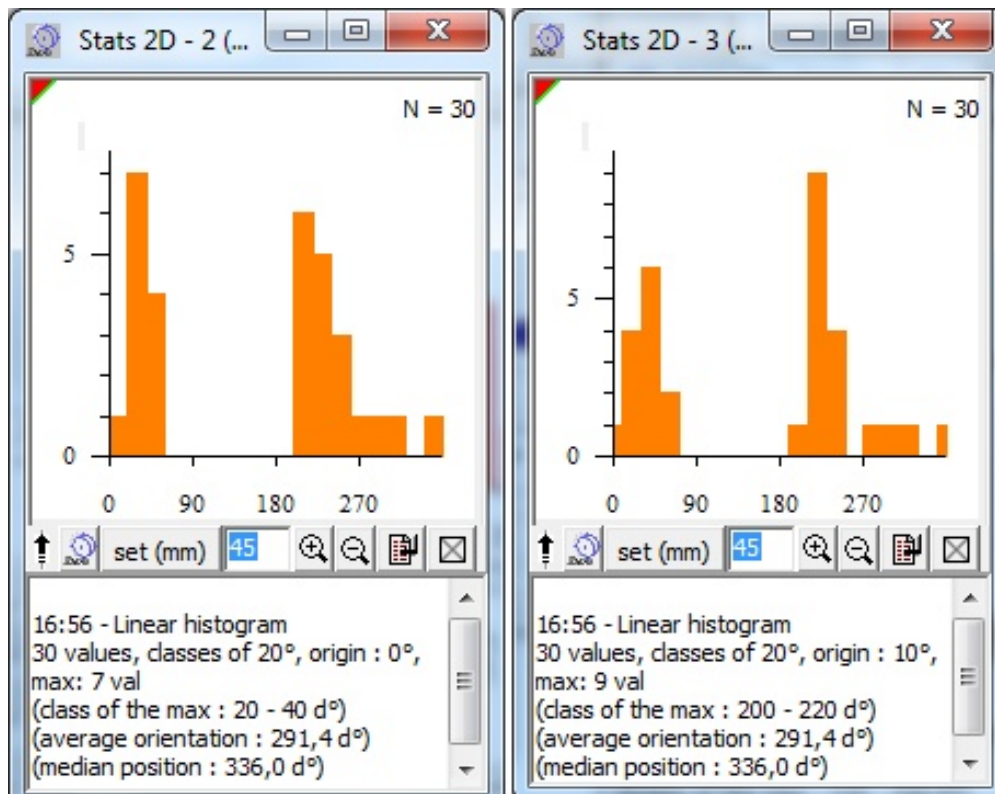


Fig. 50 Two histograms for the same set of data as above



Both histograms are built from the same set of data, both with  $20^\circ$  width classes. In the left histogram, the first classes corresponds to azimuths  $0^\circ$  to  $20^\circ$  ( $20^\circ$  excluded). In the right one, classes are shifted of  $10^\circ$  : classes are from  $10$  to  $30^\circ$ , then from  $30$  to  $50^\circ$ , and so on. The first and last bars account for the number of data in the intervals  $0$  to  $10^\circ$  and  $+ 350$  to  $360^\circ$ . As it can be seen, the strongest mode (the preferred main orientation) seems inverted.

## Kuiper test

Testing the uniformity of a 2D distribution : the Kuiper test

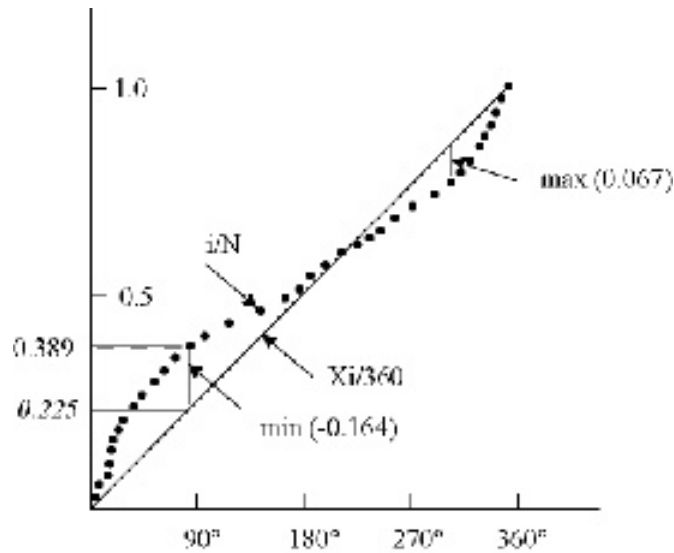


Fig. 51 Kuiper test - 1

The  $N$  data  $X_i$  are arranged in order of increasing magnitude, modulo  $360^\circ$ . The plot represents  $i/N$  as a function of  $X_i$ . If the sample is uniform,  $i/N$  would equal  $U_i = X_i/360$ , and the points would fall on a straight line.

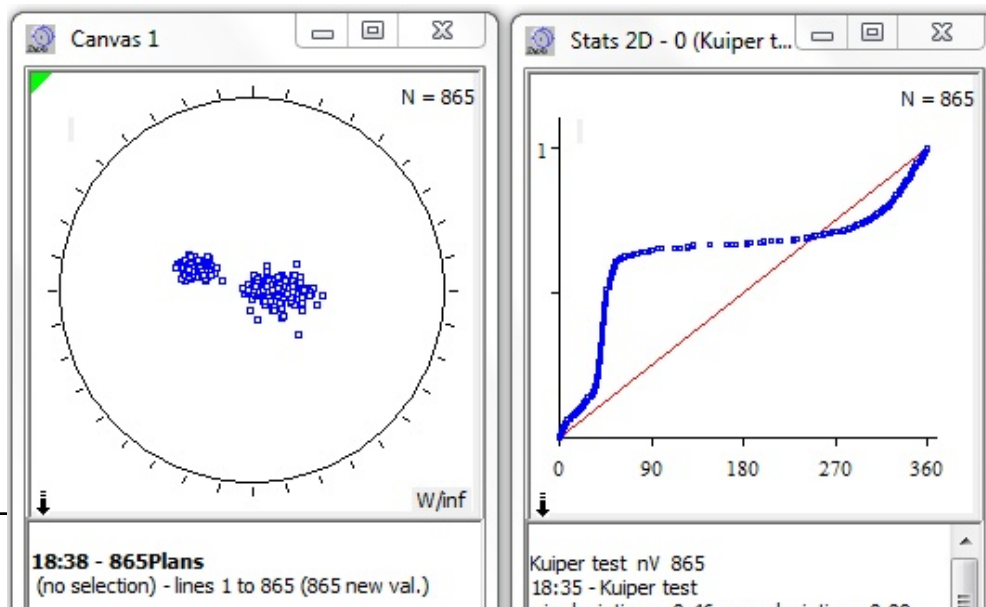
The test statistic is defined by  $V = (U_i - i/N)_{\max} - (U_i - i/N)_{\min} + 1/N$

Critical values

probability 95% :  $V_{95} = 1.75/(\sqrt{N}) + 0.155 + 0.24/\sqrt{N}$

probability 99% :  $V_{99} = 2.00/(\sqrt{N}) + 0.155 + 0.24/\sqrt{N}$

An example of (obviously non uniform) distribution



To fix the options, Kuiper function uses the same [Stats 2D dialog](#) as the others Stats 2D functions .

The "display in a new window" option, if unticked, allows you to display several Kuiper graphs superimposed in a same window. It can be useful to compare different sets of data.



Nevertheless if you resize the window, or if you save it, or print it (all operations which imply redrawing of the window), only the last curve is kept. The only way to keep the actual displayed picture is to copy it, using the copy function.

## Von Mises distribution

*Unimplemented in this version*

## Menu Faults

Provides facilities to process dataset of faults

Data must be entered in a Stem file, in a specific format. A specific [enter dialog](#) allows a fast and easy construction of such files.

You can also export such files to specific text files convenient for others faults data processors (Stress,...).

- [Enter fault + striae](#)
- Export faults datasheet
- Display
- Rotate
- [Right angle dihedra](#)
- [P and T axis](#)
- [Colors code](#)

## Enter faults + striae

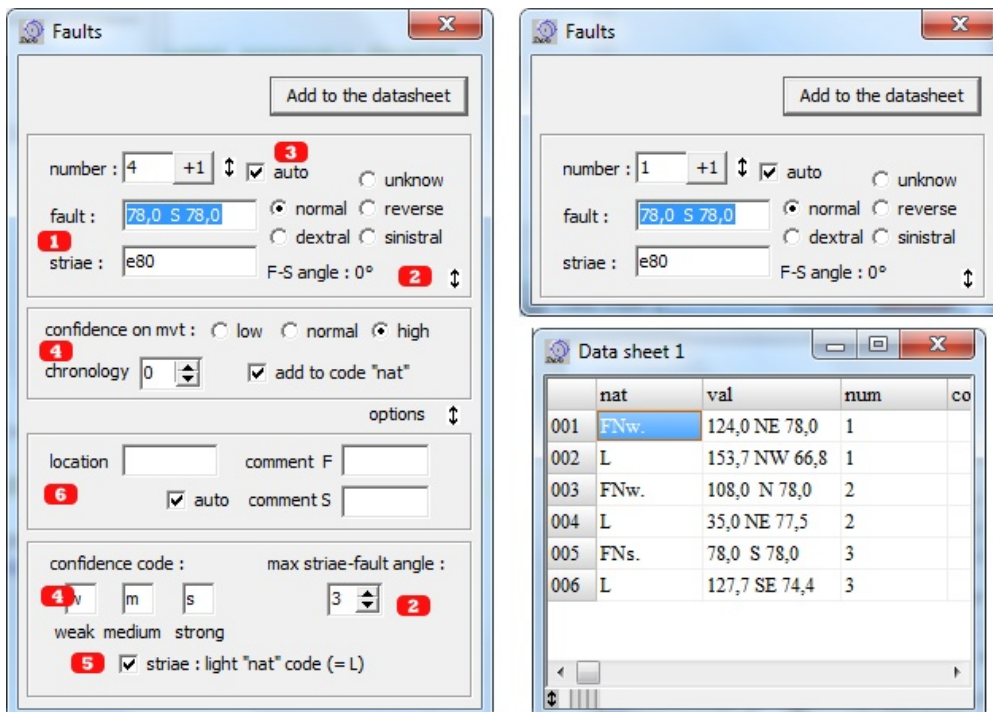
### Making specific faults data files

Datasheets containing only fault measurements are easily built up using a specific dialog, the "Enter fault dialog". In a faults datasheet, a striated fault plane corresponds to 2 adjacent lines of the datasheet : one for the fault and the next one for the striae.

The code "**nature**" of the fault gives the information needed by fault-inversion processors. It has 4 characters, in the following order :

1. first character : given data is the fault plane (F, first line) or its striae (L)
2. the sense of movement : it is a normal fault (N), reverse fault (R), dextral (D) or sinistral (S) strike-slip fault
3. (non-compulsory) the reliability of the sense of movement
4. (non-compulsory) (last character) : a number giving the relative chronology (1 to N) of the faults, or of the movements on a same fault. If a fault displays N striae orientations, it is displayed in the sheet as N distinct faults.

Missing characters are marked by a dot (.). Even if not needed when processing the data to find palaeo- stress or strain tensors, a numbers (code "number") is added to each fault-striae pair. It allows the re-identification of the fault once plotted in a canvas. Two additional codes can be added to have a more complete identification of the data.



### Fault and striae orientations

For the fault, give its complete orientation, in the current format for a plane.

Orientation of the striae can be given by :

- its complete orientation. The angle between the fault plane and the striae is calculated, and the data is rejected if this angle is more than a given limit value (**2**, in the Options)
- its pitch only (as in the given example), the usual way of proceeding. Give the pitch (from 0° to 90°) and its "sense" (side of the fault from which the pitch angle was measured) given by the quadrant (N, S, E or W, upper or lower-case, before or after the value itself, separated or not by a space).
- its trend only, from 0 to 180° (convenient for low angle faults),
- its plunge only (caution : two possible lines for a given plunge, follow the conventions used for the "[Lines and planes](#)" utility).

The complete orientation will be recalculated and displayed in the datasheet when transferring the data to the datasheet of faults ("Add to the list" button).

### Options

*To unfold the dialog and access to the options, click in the small arrows at the right of the dialog*

**2** max striae-fault angle : if you have measured in the field the full orientation values of both the fault and the striae, most of the time the given striae will not lie exactly in the given plane. Nevertheless, the orientations can be accepted if the discrepancy is small, less than a maximum angular value. To avoid any problem in further processing of the data, better to give only the pitch (for a steep fault) or the strike (for a low angle fault) of the striae, and let Stem recalculate the full orientation of the striae.

**3** auto: automatic incrementation of the fault number, either +1 or -1. Click in the small double arrow on the right of the checkbox to change the sense of incrementation.

**4** confidence, chronology : you can add to the code "nature" a character which indicate the reliability of the fault movement determination (tick the "add to code nat" checkbox).

You can also add a a number giving the relative chronology of the fault.



caution : if you export the file, check the compatibility with the processing soft.

**5** Striae, "nature" code. All the information needed to process a given fault is already given in its "nature" code. You can duplicate this information in the paired striae code, or keep only the letter "L" as "nature" code for the striae.

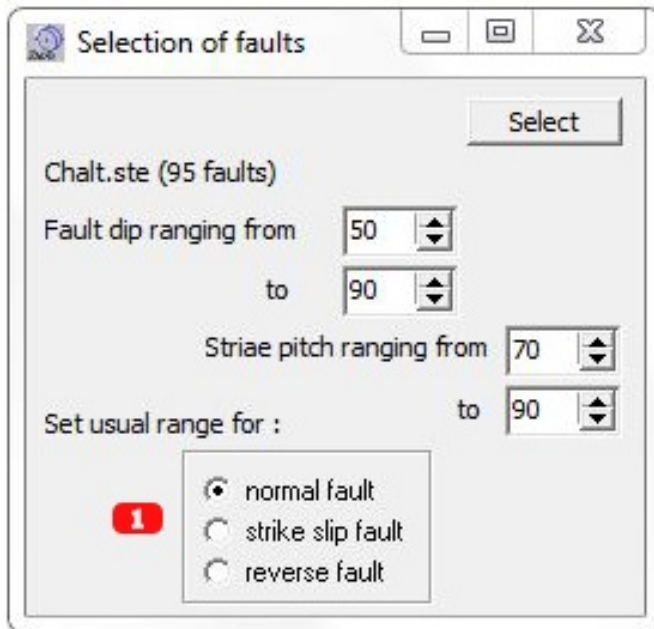
**6** Comment : to enter the non-compulsory "location" and "comment" codes. Tick the "auto" check box to give the same codes to the paired fault and striae.

## Sort on dip and pitch

Selecting in a set of faults the subset of faults fitting given dip and pitch criteria

Before processing inversion of heterogeneous sets of striated faults planes, it is often useful to select the faults on dip and pitch criteria :

- Steeply dipping faults which striae have a high-pitch angle are probably normal faults, made in an extensive strain regime
- Steeply dipping faults bearing striae at low-pitch are strike-slip faults made in a compressive strain regime
- Low dipping faults are most often reverse faults made in a compressive strain regime, but can also be detachment faults.



A dialog lets you fix the range for the dip of the fault and the range for the pitch of the striae (upper and lower bound included). A set of predefined usual dip and pitch values for normal faults, strike-slip faults and reverse faults is available. Click in the corresponding radio-button **1** to set it.



Sorting on dip and pitch can be made only if the active datasheet contains only faults, in a specific order : first line of the datasheet must be a fault plane, the first nature of its "nature" code must be "F", second line must be the striae, its nature code must starts by "L", third and fourth lines contain the second fault, and so on. Such a datasheet is most easily done using the [Enter fault + striae](#) function.



## Stress 331

Stress Exportation of a set of faults + striae data to J. Angelier's "Stress" software

(Stress 331, improved version by Th. Villemim)

	nat	val	num	com	loc
001	FN1B	12 W 74	1	96-1 p81	Chalt
002	LN1B	120 NW 73	1		Chalt
003	FS1B	100 S 84	2	96-1 p81	Chalt
004	LS1B	100 W 1	2		Chalt
005	FS1B	92 N 89	3	96-1 p81	Chalt
006	LS1B	92 E 4	3		Chalt
007	FS1B	98 N 88	4	96-1 p81	Chalt
008	LS1B	98 E 11	4		Chalt
009	FN1F	32 SE 85	5	96-1 p81	Chalt
010	LN1F	39 NE 55	5	sens ?	Chalt

Chalt											
Chalt	1	C	N	1	282.0	74.0	300.0	0	0.0	0.0	0.0
Chalt	2	C	S	1	190.0	84.0	280.0	0	0.0	0.0	0.0
Chalt	3	C	S	1	2.0	89.0	92.0	0	0.0	0.0	0.0
Chalt	4	C	S	1	8.0	88.0	98.0	0	0.0	0.0	0.0
Chalt	5	S	N	1	122.0	85.0	39.0	0	0.0	0.0	0.0
Chalt	6	S	D	1	93.0	85.0	4.0	0	0.0	0.0	0.0
Chalt	7	C	D	1	293.0	86.0	206.0	0	0.0	0.0	0.0
Chalt	8	C	S	1	160.0	80.0	73.0	0	0.0	0.0	0.0
Chalt	9	C	S	1	141.0	71.0	62.0	0	0.0	0.0	0.0
Chalt	10	C	S	1	176.0	76.0	91.0	0	0.0	0.0	0.0
Chalt	11	P	N	1	252.0	54.0	305.0	0	0.0	0.0	0.0
Chalt	12	C	S	1	179.0	66.0	98.0	0	0.0	0.0	0.0
Chalt	13	C	S	1	168.0	85.0	78.0	0	0.0	0.0	0.0
Chalt	14	C	S	1	136.0	84.0	48.0	0	0.0	0.0	0.0
Chalt	15	C	D	1	260.0	71.0	171.0	0	0.0	0.0	0.0
Chalt	16	C	S	1	152.0	88.0	63.0	0	0.0	0.0	0.0
Chalt	17	C	S	1	162.0	80.0	72.0	0	0.0	0.0	0.0
Chalt	18	S	D	1	273.0	84.0	183.0	0	0.0	0.0	0.0



In the given example, the code "nat" follows the convention of the previous versions of Stem.  
(Stem 2)





## Yamaji

To create files in the format requested by Yamaji "Mim4" software

	nat	val	num	com	loc
001	FN1B	12 W 74	1	96-1 p81	Chalt
002	LN1B	120 NW 73	1		Chalt
003	FS1B	100 S 84	2	96-1 p81	Chalt
004	LS1B	100 W 1	2		Chalt
005	FS1B	92 N 89	3	96-1 p81	Chalt
006	LS1B	92 E 4	3		Chalt
007	FS1B	98 N 88	4	96-1 p81	Chalt
008	LS1B	98 E 11	4		Chalt
009	FN1F	32 SE 85	5	96-1 p81	Chalt
010	LN1F	39 NE 55	5	sens ?	Chalt

282.0	74.0	300.2	73.2	N
190.0	84.0	279.9	1.0	S
2.0	89.0	91.9	4.0	S
8.0	88.0	97.6	11.0	S
122.0	85.0	39.2	55.0	N
93.0	85.0	3.9	10.0	D
293.0	86.0	205.7	34.0	D
160.0	80.0	246.9	17.0	S
141.0	71.0	220.4	28.1	S
176.0	76.0	261.3	18.1	S
252.0	54.0	304.8	39.8	N
179.0	66.0	260.1	19.1	S
168.0	85.0	258.0	0.0	S
136.0	84.0	224.5	14.1	S
260.0	71.0	171.3	3.9	D
152.0	88.0	241.5	15.0	S
162.0	80.0	251.7	2.0	S
273.0	84.0	183.1	1.0	D

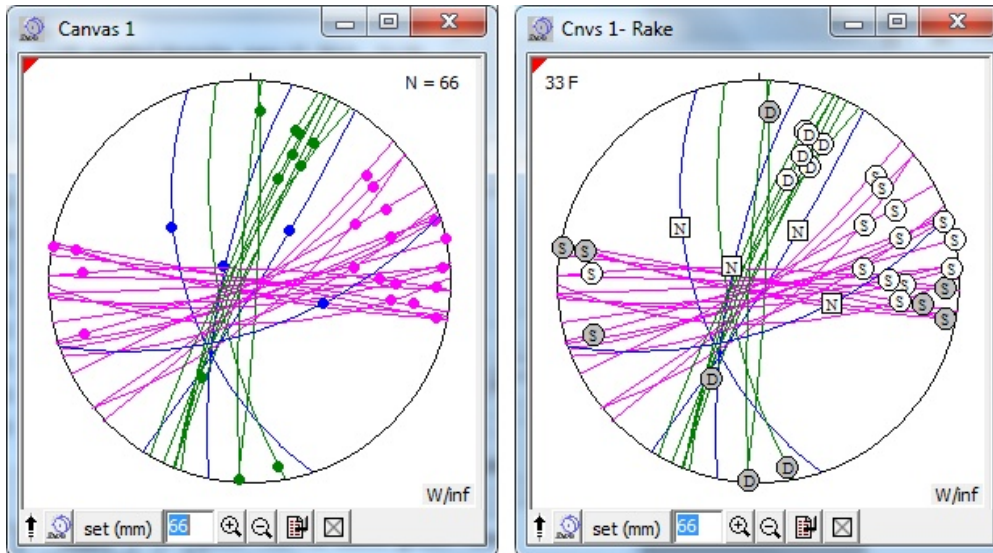


In the given example, the code "nat" follows the convention of the previous versions of Stem

## Display striae rakes

### Displaying the rake of the faults

Positive rake means that the hanging wall of the fault has an upwards down-dip component relative to the footwall. It is negative if it has a downwards down-dip component.



- Left canvas : color gives the sense of movement of the faults1 (blue : normal faults, green : dextral strike-slip fault, purple: sinistral strike slip fault)
- Right canvas : the circled letter gives the sense of movement of the faults. Grey symbols : positive rake; white symbols : negative rakes .

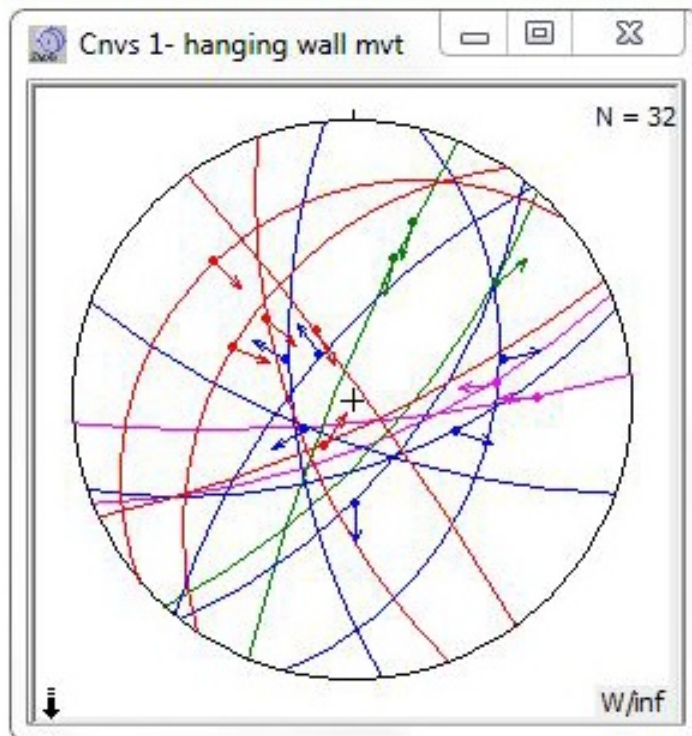
Station F06-11, Northern Pakistan. An simple example with two well defined sets of conjugate dextral (in green colour) and sinistral (in purple colour) faults, indicating a NE-SW shortening direction

## Hanging walls movements

Showing the sense of displacement of the fault hanging wall

A new canvas is drawn. Instead of the striae symbol, a arrow is drawn. It points to the direction of displacement of the upper compartment of the fault (hanging wall), when the faults are displayed in lower hemisphere projection.

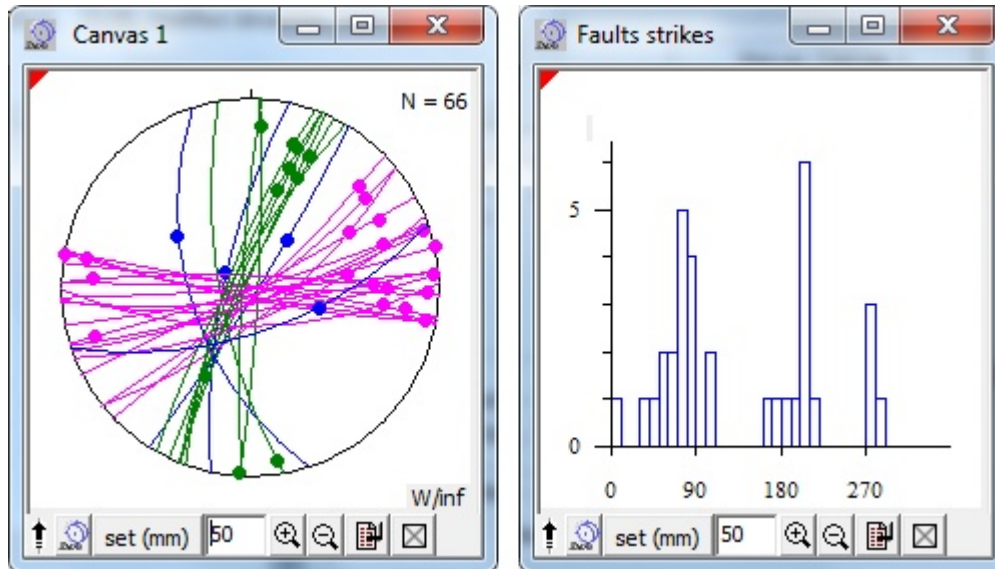
The arrows are drawn either all in a same color, or in the color of the bearing fault (as in a given example). To fix your choice : [Options](#) dialog, sheet "Stereonet" .



## Faults strikes histogram

Histogram of the faults orientations (strikes)

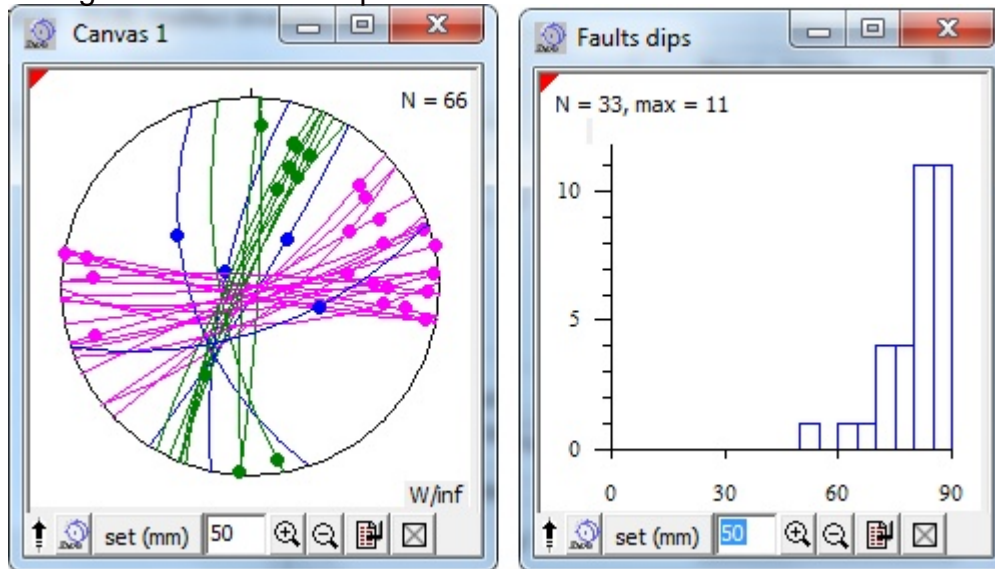
Strike is given from 0 to 360°, following the right hand rule .



Same faults as those used in the [dip](#) and [rake](#) histogram examples, and in the [rakes canvas](#) example. In the given example, the values around 60-90° corresponds to the South dipping faults (in purple on the Wulff lower hemisphere net), the values around 180-200° to the dextral strike-slip faults (in green).

## Faults dips histogram

Histogram of the faults dip



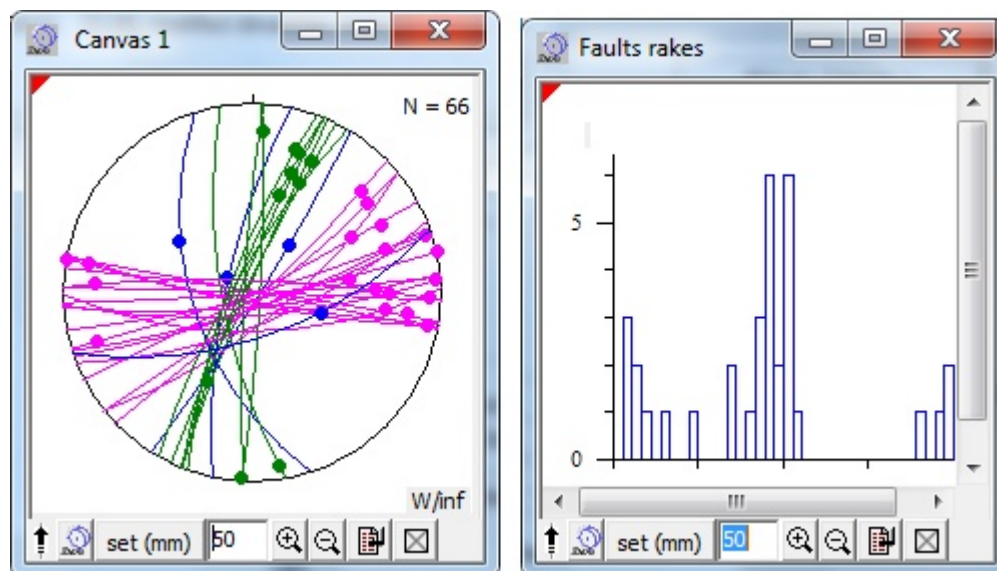
Note : If they are two faults shearing same strikes and dips, but dips being in opposite directions, will belong to the same classe



## Striae rake histogram

Another way of displaying fault statistics: rakes histogram

Positive rake means that the hanging wall of the fault has an upwards down-dip component relative to the footwall. It is negative when there is a downwards down-dip component.

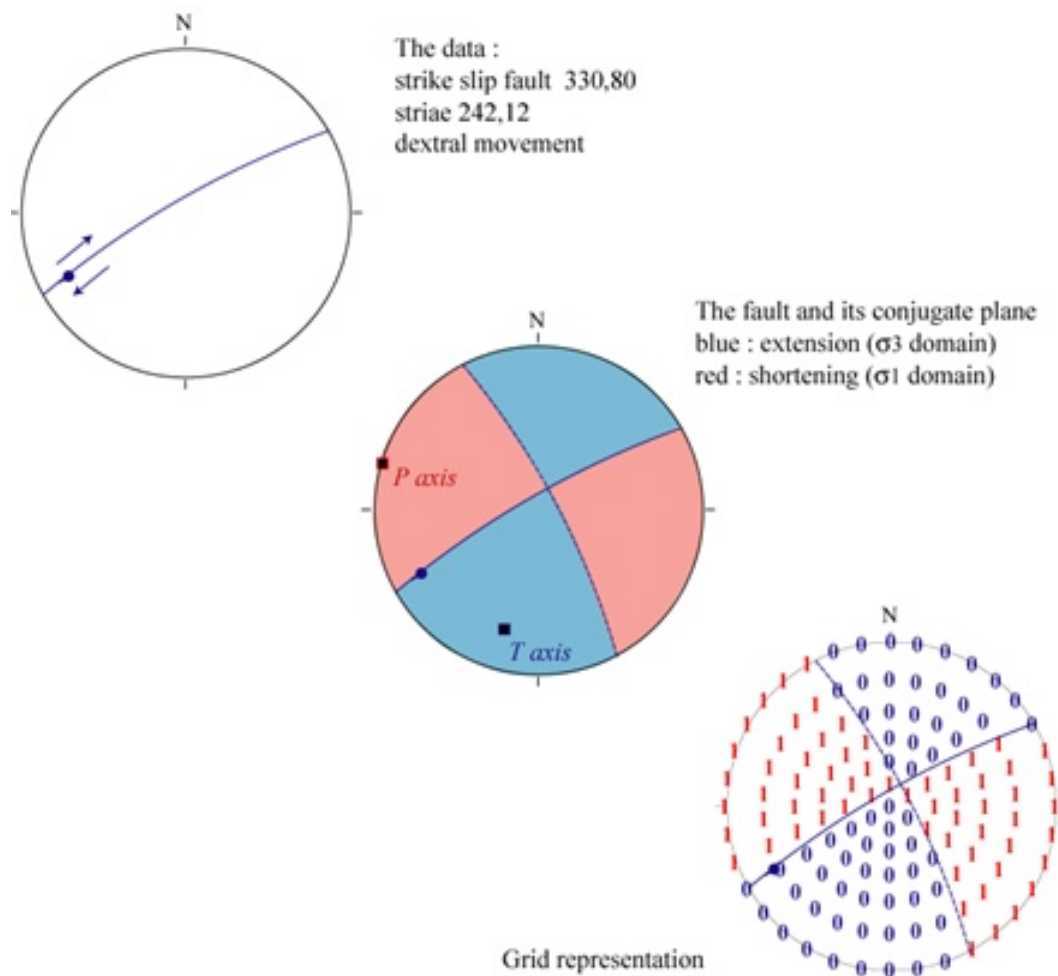


## Right-angle dihedra

### The right angle dihedra method

It is a simple method to graphically invert a set of striated fault planes, i.e. to depict from the faults and striae orientations the position of the palaeo-stress tensor (or unless the position of the main strain axis). It provides a fast and easy preliminary analysis, which can be completed by numerical approaches as Stress, Tektonics VB or Yamaji Mim4 softs.

As all the inversion methods, the right angle dihedra method accepts the basic hypothesis of Bott1, viz. the slip vector on a plane, as given by the slickenlines in the case of striated fault planes, is parallel to the shear vector as deduced from the resolution on this plane of the local stress tensor. In case of an area where all the faults movements result from a single stress tensor (in that case, the resulting faults usually appears as 2 set of conjugate faults), the right angle dihedra allows a very good first estimate of the stress axis positions (but doesn't bring any information on the shape of the stress tensor). Results are more difficult to interpretate in case of multi-phased tectonics.



### Implementation in Stem

In the right angle dihedra method, each fault is associated to an auxiliary plane, viz. the plane perpendicular both to the fault and to its striae. The fault and the auxiliary plane define 2 half-spaces : the shortening direction is included in one of the half-space, the extension direction in the other one, the choice of which is which being fixed by the sense of movement. It is assumed that the maximum  $s_1$  stress direction belongs to the shortening half-space, and that the minimum  $s_3$  stress belongs to the extension half-space.

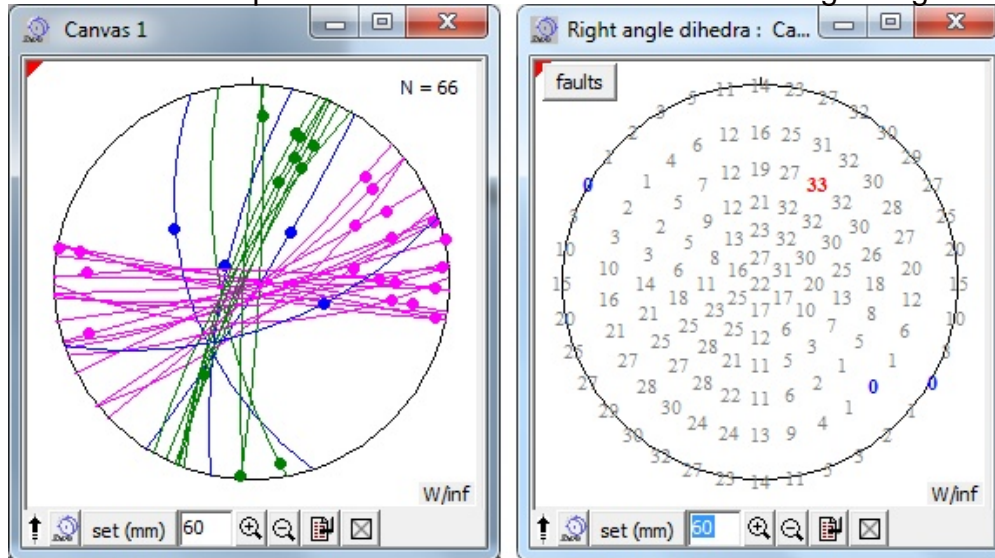
For each fault, Stem determinates the  $s_1$  permitted and forbidden half-spaces. The result is given in a canvas as values at the nodes of a regular grid : a node which is in the half-space permitted to  $s_1$  has a value of +1, a node in the half-space forbidden to  $s_1$  has a value of 0. In the given example, the fault is a dextral strike-slip fault. The striae pole, and the cyclographic traces of the fault and of the auxiliary planes have been drawn too. The two-half spaces are clearly visible.

- [Calculate](#)
- [Nod position](#)
- [Value at clicked point](#)
- [Set a nod to zero](#)
- [Isovalues contours](#)

<sup>1</sup> Bott, M.H.P.(1959). The mechanics of oblique slip faulting. Geological Magazine, 96, 109-117

## Calculate

Estimation of the position of the main stress axis via the right-angle dihedra method



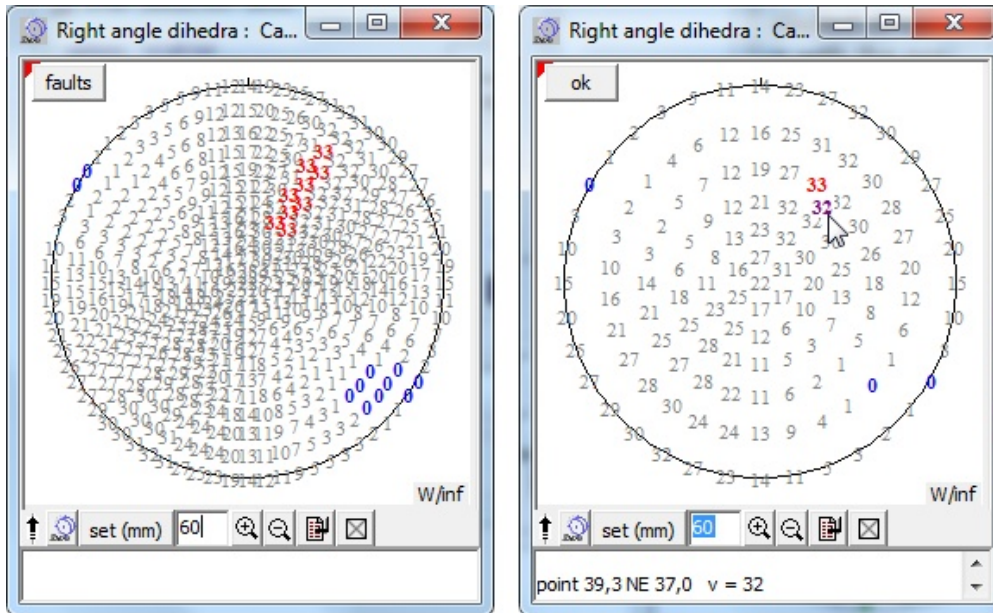
When dealing with several striated planes, if we assume that the striae are due to the same stress field, the resulting space which possibly includes  $s_1$  is the intersection (common portion) of all the individual shortening half spaces, as described above. And so on for the  $s_3$  stress, in the zone common to all the extension half spaces. For each fault Stem recognize the  $\sigma_1$  "permitted" and "forbidden" nodes, and increments accordingly the corresponding nod values.

The given example corresponds to a set of 33 faults (colour code : purple for sinistral faults, green for dextral ones, blue for normal ones). It is a simple case, where the faults are rather well clustered in two sets of conjugate faults. The grid shows that a small part of the space is  $s_1$  compatible for all the fault (nod value of 33, which means that for all the faults, this nod was included in the  $s_1$  allowed space), and a small part  $s_3$  compatible (nod value of 0). We can reasonably assume that these nodes correspond rather well to the actual position of  $s_1$  and  $s_3$ .

## Value at clicked point

### Right angle dihedra method, enhancing counting

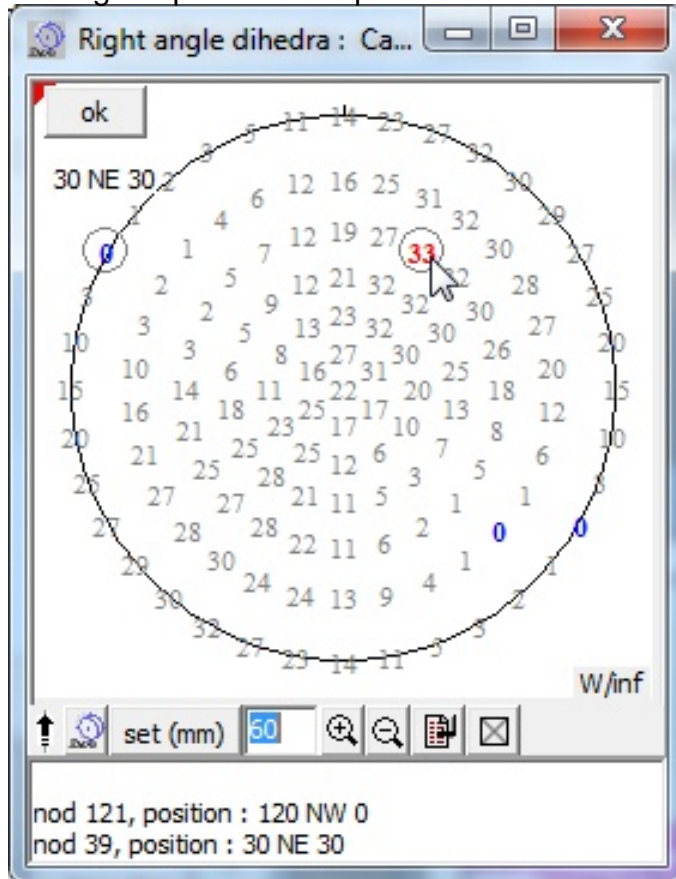
To enhance the precision when using the right angle dihedra grid, it is either possible to use a net with more nodes (below left), increasing the number of crown in the grid (cf. menu [Options](#), sheet Stats1), or to recalculate the number of compatible faults for a selected direction (below right).



Value at a given position : click in the counting canvas to fix the selected direction. The value in this point is added to the grid. It is repeated in the info zone of the window, together with the position of the clicked point.

## Nod position

Finding the position of a particular nod

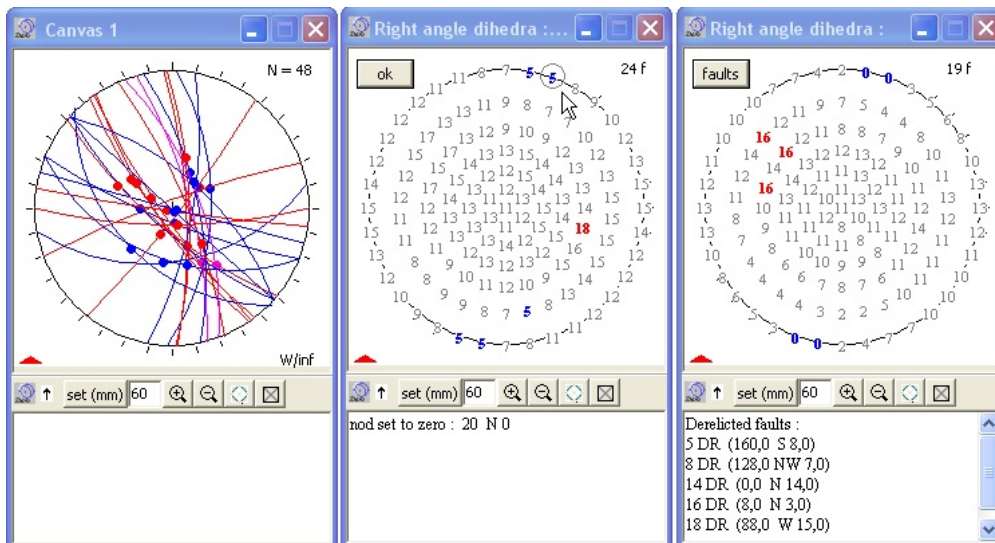


A tool to find the position of a nod of the grid used to display the right angle dihedra analysis results. Click on the nod, its position is given in the info part of the plot window.

## Set a nod to zero

### Forcing to zero a particular nod

In an area where all the faults movements result from a single stress tensor, the right angle dihedra analysis allows a good first estimate of the stress axis position. But if the tectonic story is more complex, with superposition of several stress states in the same area, the right angle dihedra method is no more quite reliable. Nevertheless, when there seems to be predominant effect of one specific deformation, you can use this function to see what are the faults which are definitively not compatible with this deformation.



In the given example, a large amount of the faults movements can be explained by a stress regime with sigma 1 roughly WNW-ESE (maximum of 18). But unless 5 faults display movements incompatible with this orientation (nods with a value of 5). If you click on one of those nods, Stem will recalculate the grid, keeping away the faults which have contributed to the non-zero value at this nod. The right canvas gives the new result : 5 faults have been thrown out (they are listed in the info zone), the sigma 3 and sigma 1 positions are better defined, even if there is still not a full compatibility of all the faults (only 16 amongst 19 in the sigma 1 zone).

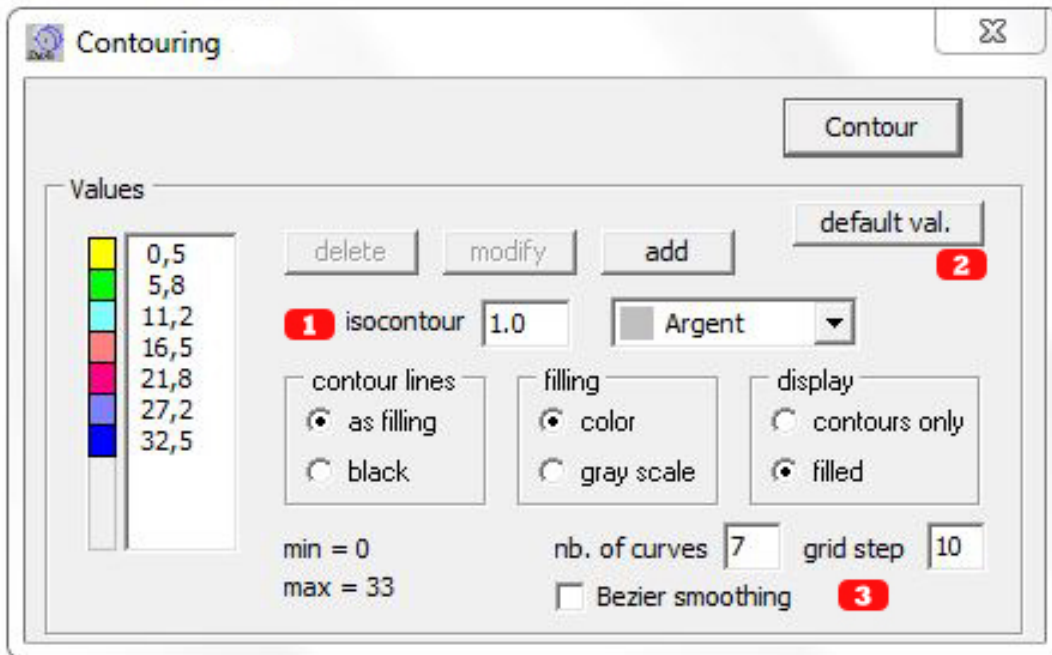


## Isovalues contours

### Contouring the right angle dihedra grid

Values are first calculated at the nodes of a new rectangular grid (different from the grid used in the Counting function, which has a hexagonal symmetry). Mesh of the new rectangular grid can be changed to get more or less smoothed contours. Minimum mesh size is 5.

A dialog let you fix the contouring and drawing options.



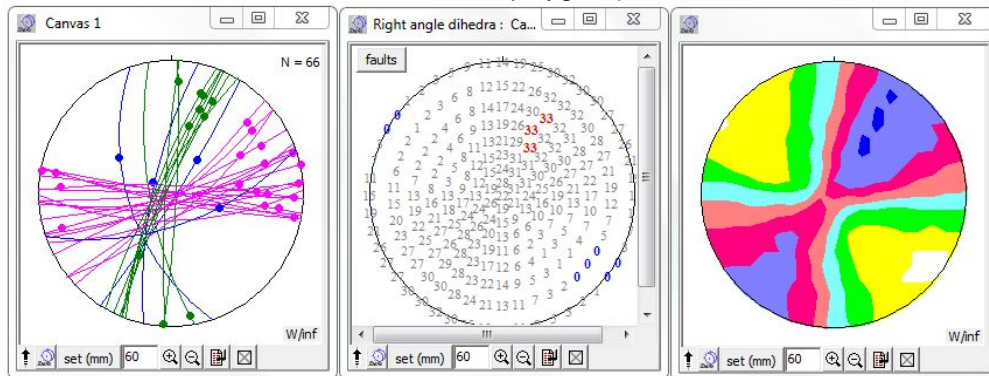
- **Isocontour** : to fix the values of the isovalues curves, and the color (or gray density) attributed to each value. To add an isocontour : button "add"; the new value is inserted in the values list. To delete or modify an isocontour : select it the value list, then buttons "delete" or "modify". To select or modify a color, use the drop down list of colors (predefined Window's colors, or a personalized color when clicking in the first item of the list). To select various gray colors, modify the gray percentage.

- **Display** : you can draw only the contour line itself, or paint the area inbound the contour.
- **Filling** : to shift between color drawing or gray drawing.
- **Contour lines**: contour lines drawn using a black pen, or in the selected color (or gray level).
- **Default values** : to get a suggestion for curves levels (given values are dependent on the maximum density) and colors. To change the whole set of default colors, go to menu Options.
- **Grid step** : to fix the grid mesh. Larger it is, more smoothed are the contour lines. As contouring is in any case a non-neutral and bit biased tool to present the data, and as calculation is fast, you can do several tries to test which choice gives the most demonstrative result.
- **Number of curves** : number of curves drawn when using the "default values" option. Curve will



be regularly stepped between the maximum and minimum value.

- Isovalues : density value at a given nod given either as number of data in the counting cone ("raw data"), or normalized to the uniform distribution.
- Bezier smoothing : each contour is actually a succession of segments, each segment joining 2 sides of each cell of the counting grid. The faster way to draw the contours is to draw each segment, and to set the option "contour line" to : "as filling". But if you want to improve the contouring aspect using a drawing soft (which can be done if you save the canvas as an emf file), it will be hard to do. A better solution, even if slightly more time consuming, is to combine these segments in a polygon, which will be smoothed as a Bezier curve. This option is the best one if you want to display only the contours lines, but cannot be used in Stem if you want to paint the curve-enclosed area (if so, the contour lines will be drawn as unsmoothed polygons).



From left to right : a set of 33 faults; right-angle dihedral calculation; isovalue contours. From the contoured canvas, one can more easily see at a glance that the extension axis is well defined, while the shortening axis is more poorly defined.

## P-T axis

Plotting the P and T axis for a set of faults

Report in a canvas of the individual P and T axis calculated for each fault of a set of faults.

## Faults maker

A tool to build an artificial set of faults

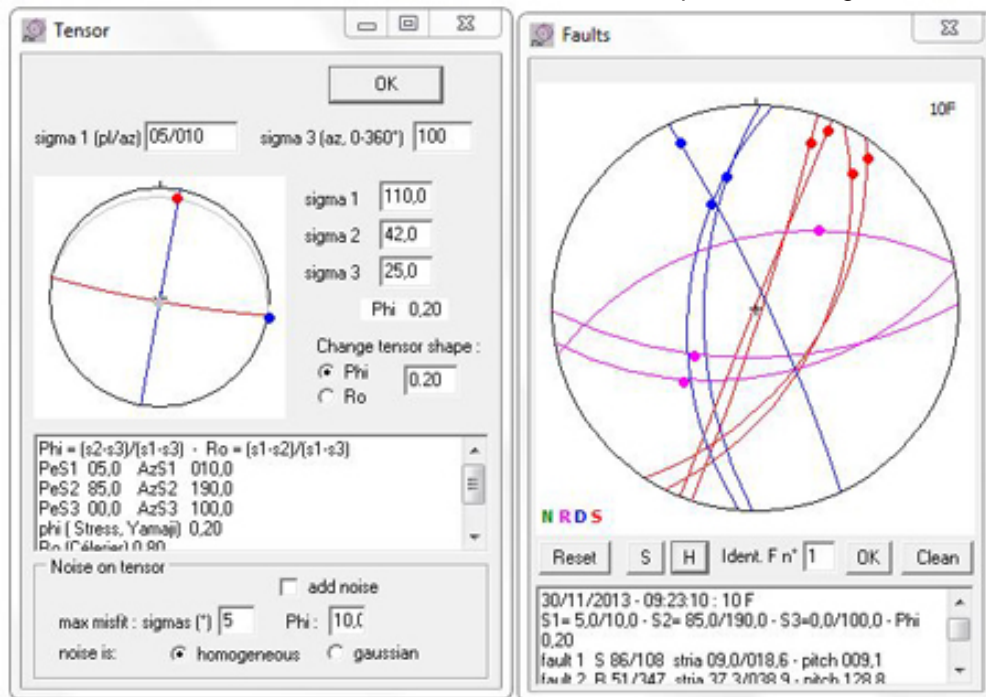


*FMaker is not implemented in this version of Stem, but can be obtained on request as an independant freeware. It uses the same data files as Stem do.*

FMaker is a tool to test the results obtained when inverting a series of striated fault planes to get back a stress tensor.

It is designed to :

- test the effects of a given tensor on a given set of plane, to compare theoretical and actual orientations of the striae,
- to create artificial set of faults, from a random set of planes and a given tensor.



A random set of planes, with theoretical striae positions due to a stress field as defined in the left dialog.

## Menu Windows

Selecting or hiding specific windows

- [Arrange](#)
- [Close datasheets](#)
- [Close plots](#)
- [Close windows text](#)

## Arrange

Stacking of the windows below the Stem main window

## Close datasheets

To close all the data sheets

## Close plots

To close all the canvas or other drawing

## Close windows text

To close all the text windows



## Menu Options

To fix the Stem options

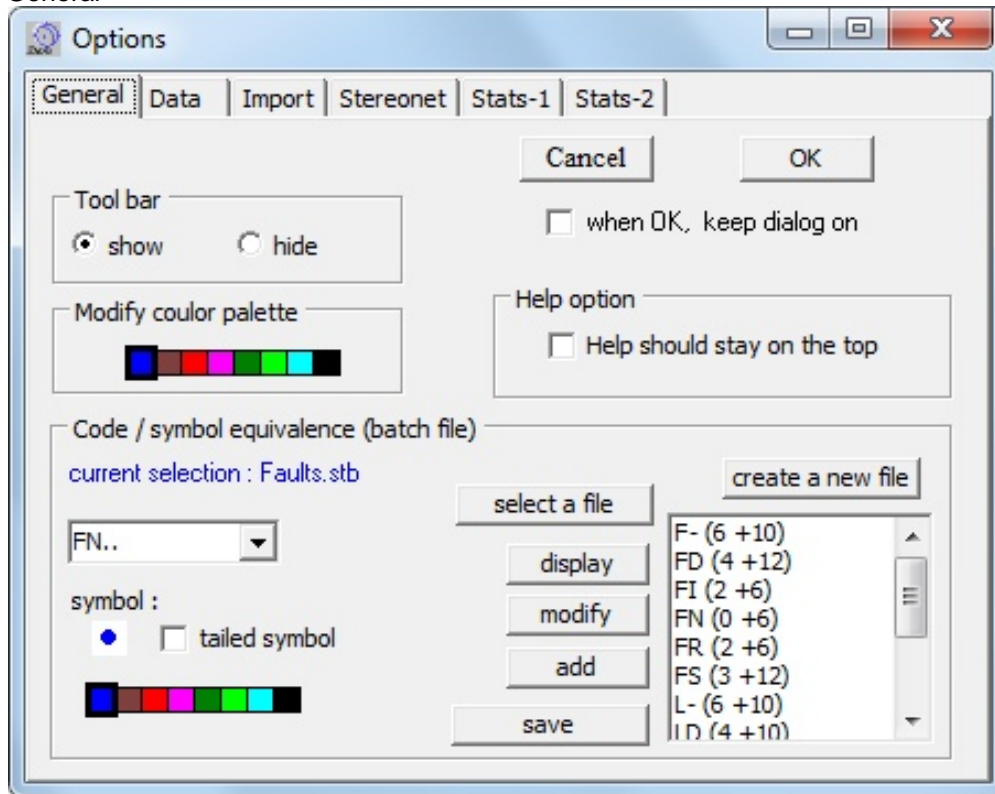
- [Choose](#)
- [Character](#)
- [Tool bar](#)
- [Save options](#)
- [Save on quitting](#)

## Choose

Fixing the default styles and other options of datasheets and canvas

Remark: to change the style of the datasheets or of the canvas, you can either use this command (you will modify altogether the style for the different visible windows), or click with the right button of the mouse on the window you want to modify (it allows the simultaneous display of windows with different styles, for instance, juxtaposition of Schmidt and Wulff stereonet). Some options are only available through the options menu.

General



Data

Options

General | **Data** | Import | Stereonet | Stats-1 | Stats-2

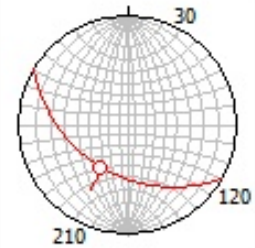
Cancel OK

Data format

planes Az Quadrant Dip (120 S 40)

lines Trend, Quadrant, Pl (30 S 40)

Display decimal values



Codes names

Old	New
val	val
nat	nat
num	num
loc	loc
com	com

Add magnetic declination    declination 0,0

Can edit in the grid (multiple selection impossible)

When printing data tables : print the grid

## Import

Options

General | Data | **Import** | Stereonet | Stats-1 | Stats-2

Cancel OK

import Stem text file

planes Az / Quadrant / Dip (3 col)

lines Trend / Quadrant / Plunge (3 col)

import raw data

add code number     planes     lines

format Dip / dip direction (2 col)

Stem file : col. nb for

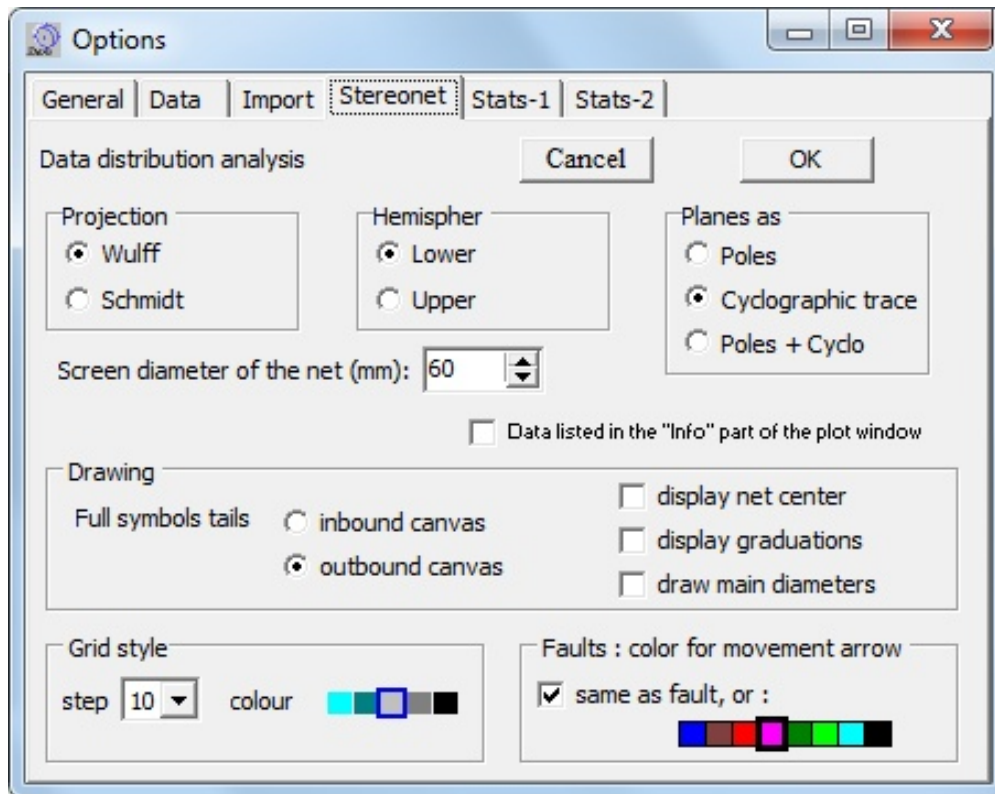
value	2
nat	1
num	5
loc	6
com	7

separator slash (/)

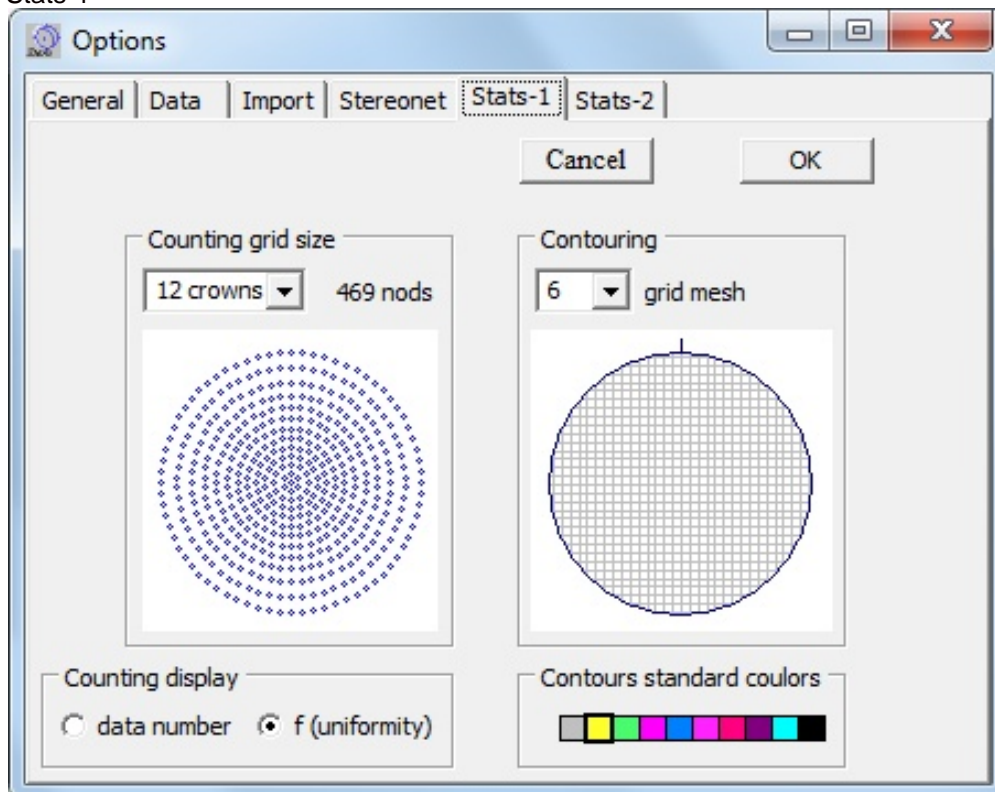
*Stem text file : text formatted in up to 7 columns in a given order, possibility to uses codes to sort data (see Help menu).*

*Raw data : text formatted in 1 to 3 columns (depending of the format), a homogeneous set of data (set of lines or set of planes), no codes*

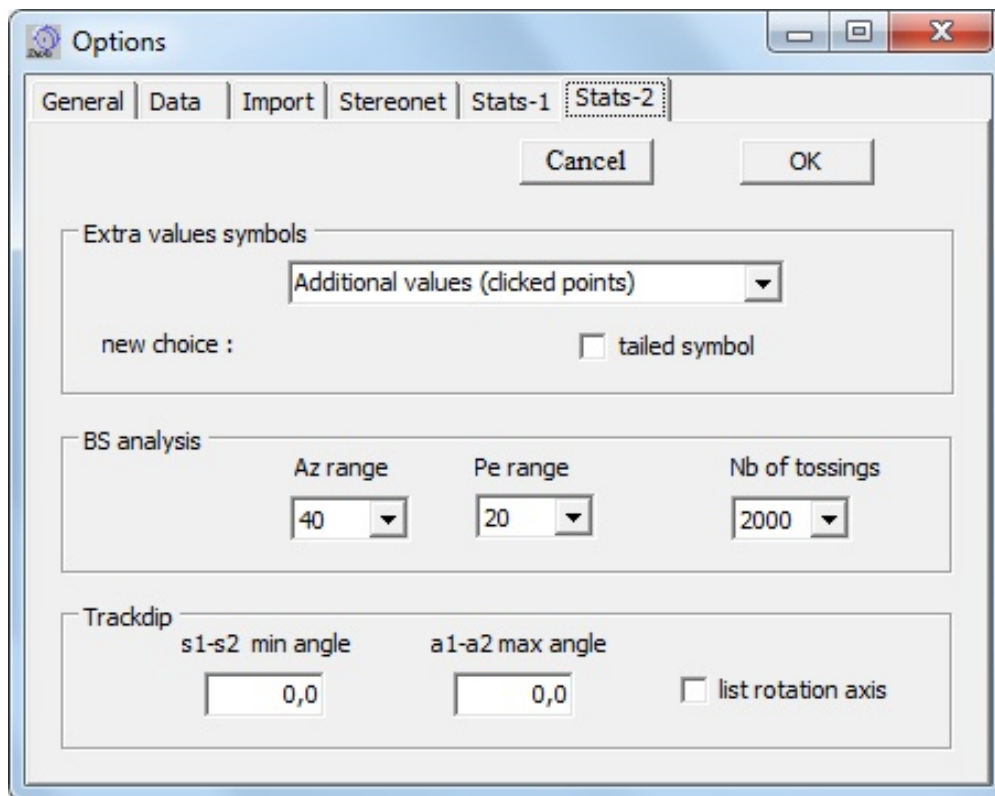
## Stereonet



Stats-1



Stats - 2



## Characters

Selection of the characters set used in the datasheet

Use the standard Window characters selection dialog to modify the default characters set

## Hide tool bar

To hide or show the tool bar in the main Stem window

## Save options

Saving the current options



## Save on quitting

Automatic saving of the current options when quitting

## Menu Help

## Summary

## Index

## Search in help

## Miscellaneous

- [Shortcuts](#)
- [Using the shift key](#)
- [The datasheet window](#)
- [Data format](#)
- [The plot window](#)
- [Symbols file](#)
- [Additional values](#)
- [Select symbols dialog](#)

## Shortcuts

### Some shortcuts for current operations

Simple click with the right button of the mouse

- Click in the [data sheet](#): pop-up menu to change the display format of the measurements
- Click in the [canvas](#) : pop-up menu to change its style (Wulff/Schmidt, upper/lower hemisphere...)
- Click in the data format field (lowermost part) of the dialog [Enter \(key in\)](#) : pop-up menu to change the format of the measurements
- Click in one of the two data edit boxes: in the dialog [Enter \(key in\)](#) : pop-up menu to change the display format of the measurements

Double click with the left button of the mouse

- Double-click in a canvas : list of the symbols currently used in the canvas, and corresponding codes. Possibility to make a [batch file](#) from the displayed symbols list
- Double-click in the "use" field of the dialog [Enter \(data sheet\)](#) : to display the symbols-file currently selected (if any), to change the for another one.

The tool buttons, in the Stem main window tool-bar

The Stem tool bar provides short-cuts for the most often used functions (viz [L-S utilities](#), [New data sheet](#), [Open a data-sheet](#), [Reopen](#), [Save](#), [Print](#), [Plot values](#) of the data sheet, [Rotate](#) the canvas, [Identify](#) a pole or a cyclographic trace, Calculate the [best axis](#) or the [best great circle](#), Display (i.e. rase or un-erase) the "[extra values](#)", Help, Erase the info part of the main Stem window

## Shift key

### Holding down the shift key

It modifies some functions or the way some values are displayed

In the menu "Plot"

- [Enter clicking in the canvas, new pole](#) : if you hold down the shift key when clicking in the canvas, the clicked point is assumed to be the pole of a plane, instead of a line. Accordingly, the value will be displayed by its cyclographic trace, if the cyclo option is the current option.
- [Rotation](#) : when you click in the "fix" button while holding down the shift key, the rotated values are displayed in a new data sheet

In the menu "Plot", sub-menu "Identify"

- [Clicked pole](#) : the orientation of the clicked data is given, instead of the " number" code. If the clicked point does not correspond to a data of the canvas, a default symbol is drawn at the clicked position, and the azimuth and plunge of the axis value is displayed on the canvas.
- [Clicked cyclographic trace](#) : the orientation of the clicked data is given, instead of the " number" code.
- [Poles in lasso](#) : the data which poles are in the lasso are listed in a new datasheet, instead of being listed in the " info" part of the window

In the menu "Plot", sub-menu "Modify"

- [Erase poles in lasso, Keep only poles in lasso](#): the data which poles were in the lasso are listed in a new datasheet, instead of being listed in the " info" part of the window

In the menu "Plot", sub-menu "Geometry utilities"

For all the functions in this menu, if you hold down the shift key when clicking in the " OK" button, the calculated line or plane is not added to the other data (the default option), but to the list of additional values attached to the canvas. Its value is plotted in the " info" zone. It can be displayed in the canvas using the Display best fits function.

In the menu "Plot", sub-menu "Display grid net"

- [Grid axed on clicked position](#) : the orientation of the grid axis is written in the canvas

In the menu "Stats 2D"

[Rose diagrams](#) and [circular histogram](#) : when clicking in the "list" values tool button  (tool bar at



the base of the plot), the number of values in each class is listed in the info zone of the plot window instead of a new text window.

## Data window

### Edition of the data

Stem use **datasheets** to edit the measurements. It is possible to have up to 16 datasheets simultaneously displayed, and each datasheet can have its own "style" (for instance, different data formats, or integer/decimal options)

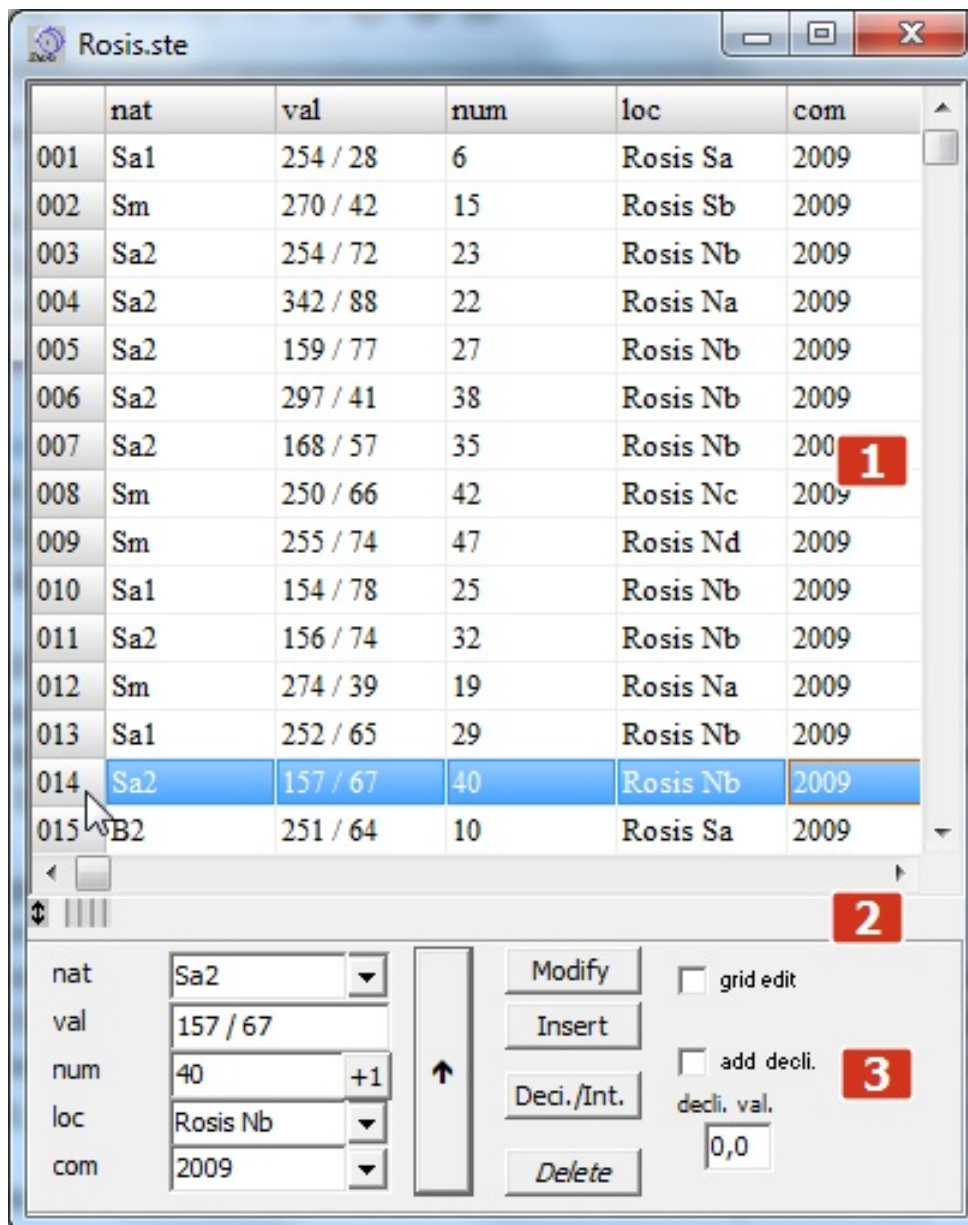


Fig. 53 A datasheet

1. Table of data
2. Double arrow to hide/show the lower edit part, icon to re-arrange the columns
3. Edit zone

## The data table

Each line corresponds to one measurement; each measurement can have up to 4 codes attached to it, to indicate the type of value, to give it a number, ... A code can have up to 9 alpha-numeric characters.

You can modify at any time the [format of the data](#), by clicking in the table with the right button of the mouse. You can change the order of the columns or the order of the rows (use the mouse to drag the rows or the columns to the requested position). You can sort the data on any column (item [Sort](#), sub-menu Data utilities)

## About the codes

- The "nature" code is compulsory, as its first character is used to distinguish between planes and axis when plotting the data in a canvas. First character can be **S, P, F (plane)** or **L, A, B (axis)**. Upper or lower case characters admitted, and considered as different characters.
- The "number" code is noncompulsory, but normally used to group measurements taken in a same outcrop, attributing to each outcrop (and not to each measurement) a reference number. In several cases, Stem uses this number code to help the user to re-identify a plotted measurement. The Number code is actually a string of characters (as the other codes, it can includes letters, but this is not really meaningful), and not a number, and can be used accordingly (for instance, in a series of number 1, 2, 3,...19, 20, 21... sorting using the "Numbers as strings" in the Sort function will give the following result : 1, 10, 11...19, 2, 20,...).

## The edition zone

The lower part of the datasheet is designed to enter the new data or to modify the data already in the table. You can hide (or show) this part of the window by clicking on the small double arrow at the bottom-left of the data table.

## Buttons and options of the "edit" part of the sheet

- Vertical arrow button: to transfer the data from the edit zone to the table
- Modify button : you can edit a line (click in the line number, as in fig.) or a single cell (click in it) of the table. Content of the selected line or cell is transferred to the edit boxes, where it can be modified. Use the Change button to post back the modified values to the table
- Insert button : to insert a line above a selected line. To undo the insertion : use the Delete button
- Delete button : to delete the selected line (caution : undo possible only on the last deleted line)
- Decimal/Integer button : azimuth and dip displayed either as rounded integer values, or as one-digit decimal value (caution to the rounding of decimal values, see [Round data](#)).
- Add declination check box and Declination value : when checked, the magnetic declination is automatically added to the measurement to obtain the true bearing. Westwards declination is negative, Eastwards declination is positive.
- Grid edit : when checked, edition in a cell of the grid is possible. When unchecked, you can only

select, copy and paste the whole content of a cell.

## Data format

Formats available in Stem

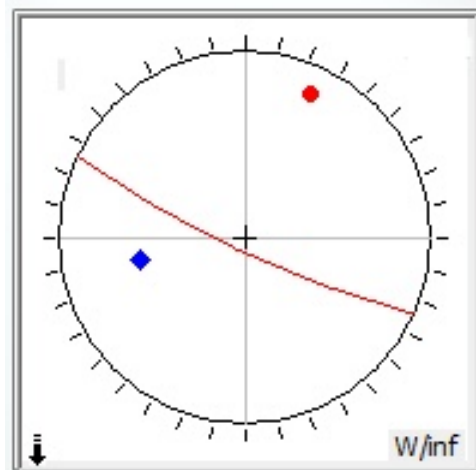


Fig. 54 Data formats available in Stem

For a plane (given example : in red)

- Azimuth Quadrant Dip : 115 SW 80
- Dip / Dip direction : 80 / 205
- Dip direction / Dip : 205 / 80
- Plunge direction / Plunge of the pole : 025 / 10
- Azimuth / Dip, right hand rule : 115 / 80

For a line (given example : in blue)

- Trend Quadrant Plunge : 78 W 30
- Plunge/Plunge direction : 30 / 258
- Plunge direction /Plunge: 258 / 30
- Lines same as planes : meaningful only if the plane is given in 1 of the 3 first formats

To change the data format

1. Click with the right button of the mouse in the table and select the convenient format in the pop-up menu. If several datasheets are displayed, only the active one is modified (i.e. you can keep different formats in different sheets)
2. Or use the Options menu. If so, all the displayed datasheets will be changed, and not only the active one

## Plot window

### Plotting the data in a Wulf or Schmidt canvas, and other drawings

Canvas (either Schmidt or Wulff), as well as other graphs (for instance Eigen values graph) are displayed in specific windows (plot windows). It is possible to have up to 16 canvas simultaneously displayed, and each canvas can have its own "style" (for instance, a set of data can be displayed in a Schmidt net, while the same set or another set will be displayed in another window in a Wulff net).

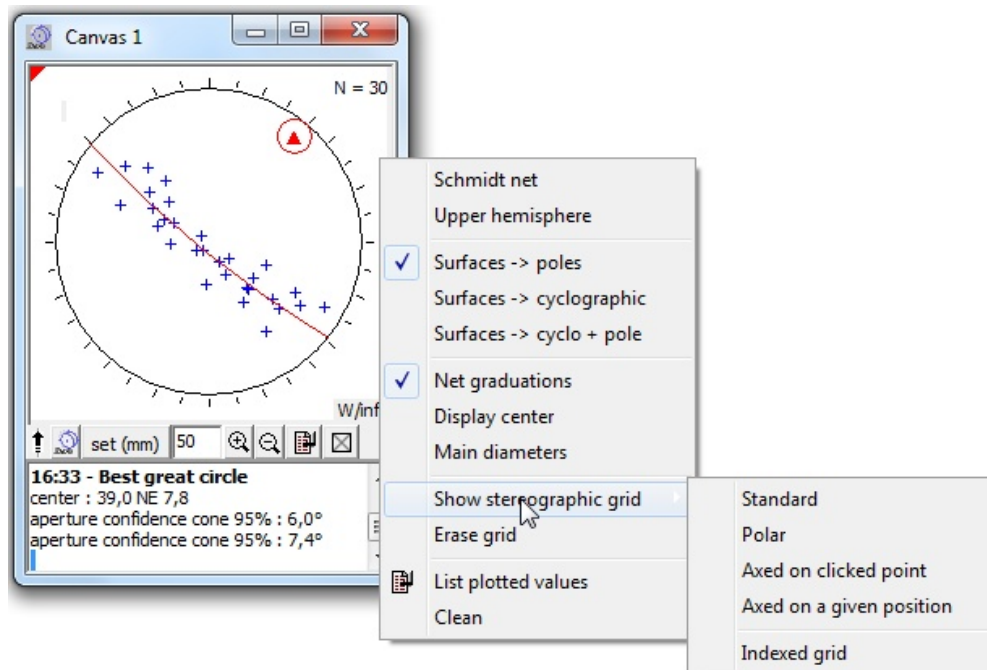


Fig. 55 Wull canvas in a plot window and the related pop-up menu

### The drawing zone

- Click in the canvas with the right button of the mouse to get a pop-up menu to fix the style of the canvas,
- Double-click in the canvas with the left button of the mouse to list the symbols and corresponding codes currently used in the canvas. You can keep them in a batch symbols-file. To erase extra drawing in the canvas (for instance the lasso) : menu Plot, [Clean \(Ctrl K\)](#)

### The tool bar

- Canvas button : to change the style of the canvas ("style" pop up menu)
- Up (or down) arrow button : to show or hide the info part of the window and the tool bar
- Set button : to set the canvas diameter to a given value (the size of the window will adapt to this value, except if larger than the screen)
- Zoom-in button : another way to zoom the canvas.

- Zoom-out button : unzooming. The size of the window is adapted to the new size of the canvas.
- Transfer button : to display in a new datasheet all the data plotted in the canvas, and only those ones
- Size button : to readjust the canvas size to the window size, when you change it.
- Clear button : to clear the text in the info part of the window

### The info zone

To show or hide the info zone click in the arrow of the tool bar, or go to menu Options. The info zone is used to give some specific informations or calculation results (f.i. list of the plotted values, results of best fits calculations...)

## Symbols file

Keeping the symbols in a batch file (= symbols-file), or using an existing batch file  
It is possible to keep the symbols used for a series of selections in a specific “ batch” file, used to re-attribute later the same symbol to the same type of values.

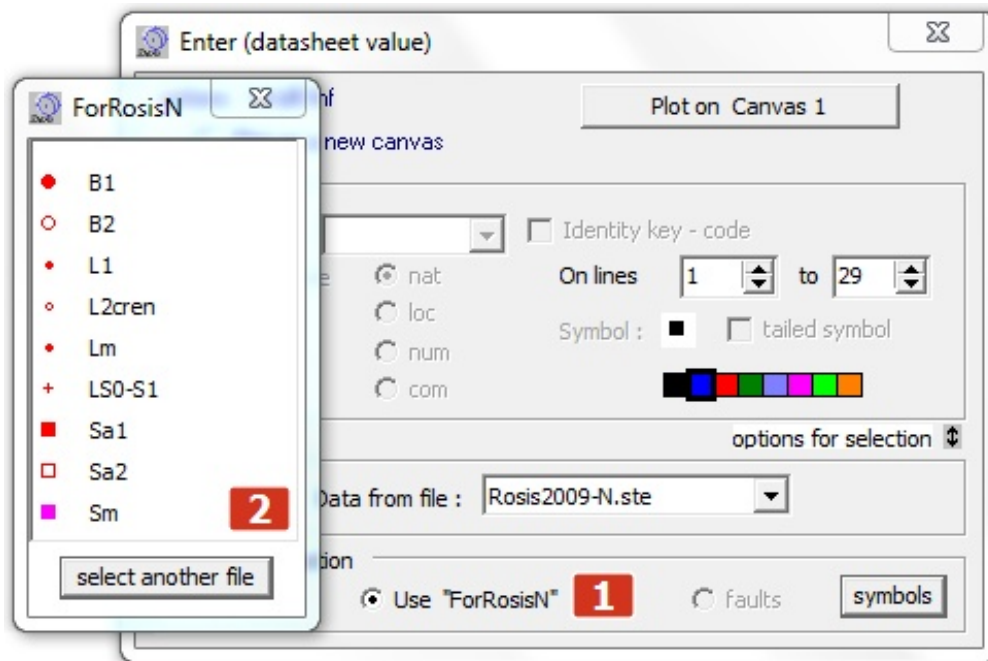


Fig. 56 Using a batch file

1. Default file, double click on its name to display its content
2. Equivalence code-symbol in the selected file

- To see the content of the currently active batch file, or to select another already existing file: either via the choose command, or from the [Enter \(datasheet\)](#) dialog, clicking in the “ Symbols” button or double-clicking on the name of the file (central radio button).

- To modify the file: via the '[Options/Choose](#)' command.
- To make a new batch file: choose command in the 'Options' Menu,

- To make a new batch file from the current canvas display : double click in the canvas. A pop-up window display the symbols in the canvas. Use the "save" button of the window to create a file with the canvas symbols.

To use the default or newly selected (or created) batch file : Unfold if necessary the lower part of the Enter dialog (click on the double arrow). In the “ Symbol selection” part of the dialog, click the radio-button “ Use “ file name” .



## Additional values

### What are "additional values"

Basically, a canvas is used to visualize field measurements (lines and/or planes), to do statistical operations on these measurements, or as a help for 3D geometrical problems (for instance rotations). Most often, the measurements are read from a file, sometimes read once at time using the computer key board or clicking in the canvas. Stem keep all the measurements of a canvas in a first table, attached to the plot window.

Beside field measurements, a canvas can also be used to display other data (" called here " additional values" ), viz. the results of statistical estimations (mainly calculated "best fits", for instance the great circle best fitting a girdle distribution of poles, used to find the axis of a fold), or visually estimated best-fits (f.i. a small-circle via a cloud of poles), or still the result of geometrical constructions (for instance, the bisector of 2 planes).

Results of the simple geometrical constructions (menu [Graphical utilities](#), some of them also available in the " [Line-plane value](#)" utility) can be added on request to the standard data table. If not, the resulting orientation is only kept in the Info part of the plot window.

Results of statistical estimations are all kept in a specific table attached to the canvas, even if you haven't asked their drawing in the canvas (f.i., when a best pole is calculated, the confidence cones at 95% and 99% are calculated too, and kept in the table even if you haven't checked the " confidence cone" check box in the [Best pole](#) dialog). It will be possible to plot them later, using the " [Display best fits](#)" dialog.

### List of the extra values

#### Best-fits calculated

- [Best pole](#) (set of line or set of poles of planes)
- [Best great circle](#)
- [Best small circle](#)
- [Best clusters](#)
- [Best circle distribution analysis](#)
- great circle (boot strap)
- [small circle](#) (boot strap)

#### Best-fits visually estimated

- [Great circle](#) (mouse tracking)

- Great circle (via 2 points)
- Small circle (using a grid)
- Small circle (via 3 points)

#### Results of geometrical constructions

- Intersection of 2 planes
- Plane defined by 2 lines
- Planes bisectors of 2 cyclographic traces
- Lines bisectors of 2 poles
- Intersection of a small circle and a great circle

## Select symbols dialog

Selection in a diagram of the data to be included in a calculation

Different sets of data of various types are often plotted in a same diagram, each set being distinguished by one specific symbol, or one specific color. Up to 16 symbols and 8 colors are available.

All the statistical functions deal with the measurements plotted in the canvas, either all of them or some of them only. When appropriate, the “ select dialog” let you select the data to be included in the calculation.

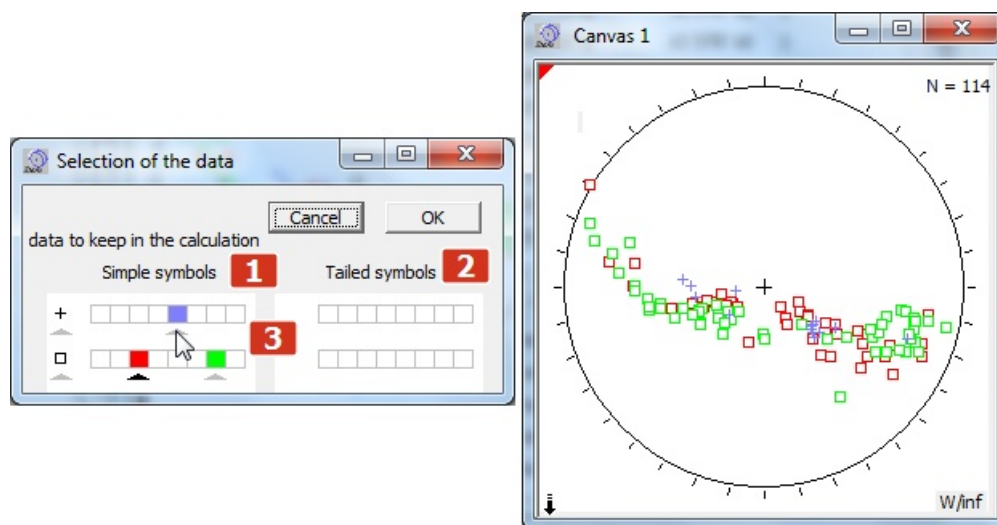


Fig. 57 The dialog to select data in a canvas

1. Active canvas, list of simple symbols
2. Active canvas, list of tadpoles symbols
3. To select a symbol, click in the selection triangle

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