

Introduction to the 3D-datainterpretation within REFLEXW

In the following the 3D-datainterpretation of REFLEXW is described including the generation of a 3D-dataset (Chap. I), the processing of 3D-datafiles (chap. II) and the interpretation of 3D-datafiles (chap. III).

Please use in addition to this guide the handbook instructions within the corresponding chapters and the online help.

I. generation of a 3D-dataset

A **3D-data file** is a single REFLEX formatted file which consists of several equidistant 2D-lines sequentially stored. All traces belonging to one 2D-line have the same ensemble-number which is stored within the REFLEXW traceheader. The direction (x or y) within the fileheader determines the direction of the 2D-lines.

Depending on the original data there are several ways to generate a 3D-file in ReflexW format:

- generate from original 2D- or 3D-data during the import (chap. I.1). In this case there are strong restrictions concerning the orientation of the original lines and the complete dataprocessing is done for the 3D-datafile (see chap. II).

- generate from REFLEXW formatted 2D-lines (chap. I.2). The 2D-lines may be raw data (then the processing is done for the 3D-datafile) or already processed data. There are no general rules whether the processing shall be done for the 3D-datafile or for the individual 2D-lines.

In any case, the data points of the resulting 3D-file have fixed increments in x-, y- and time-direction, respectively, and the max. size of the 3D-file is limited to 1024 points in each direction. The resulting 3D-datafile has the same REFLEXW format like a 2D-datafile (the ensemble number within the traceheader controls the sequential storing) and it therefore may be processed within the 2D-dataanalysis module (chap. II) whereby the interpretation must be done within the 3D-datainterpretation (chap. III).

I.1 Generating a 3D-file during the import without interpolation

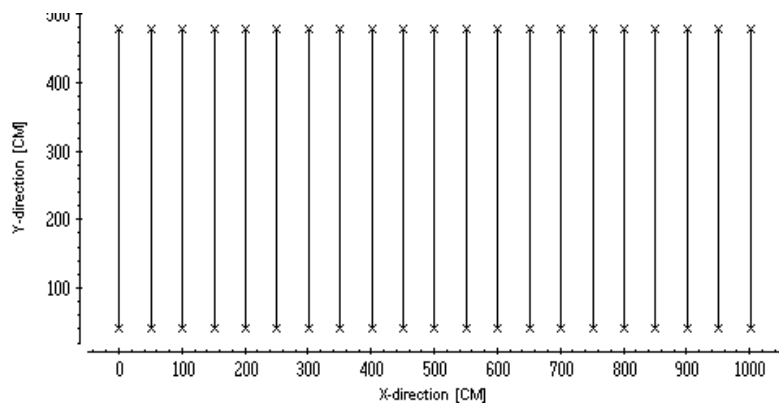
There are two different ways of generating a 3D-file during the import depending on the structure of the original data:

- the original data are parallel 2D-lines
- the original data are already a 3D-datafile

I.1.1 Generating a 3D-file from original parallel 2D-lines

The precondition is that the original data are:

- parallel 2D-lines with a fixed profileincrement (increment between the different 2D-lines) and identical startcoordinate
- fixed traceincrement
- fixed timeincrement
- same number of points per trace (identical timerange)
- same number of traces per 2D-line (identical distancerange)



Then a 3D-datafile may be easily constructed during the import by simply storing sequentially the different 2D-lines within one file. The size of the 3D-cube is determined from the number of 2D-lines, the number of traces per 2D-line and the number of points in timedirection. Example: 21 different 2D-lines with 200 traces per 2D-line (profiledirection: y) and 256 points per trace: xpoints: 21, ypoints: 200, zpoints (timepoints): 256.

In the following the individual steps for creating such a 3D-file are described in detail:

1. enter the module **2D-dataanalysis**
2. activate the option **file/import**
3. choose the following options within the **import menu**:

data type: const. offset (version 2) or 3D-const.offset (from version 3)

ProfileDirection: direction of the original 2D-lines (enter either x or y)

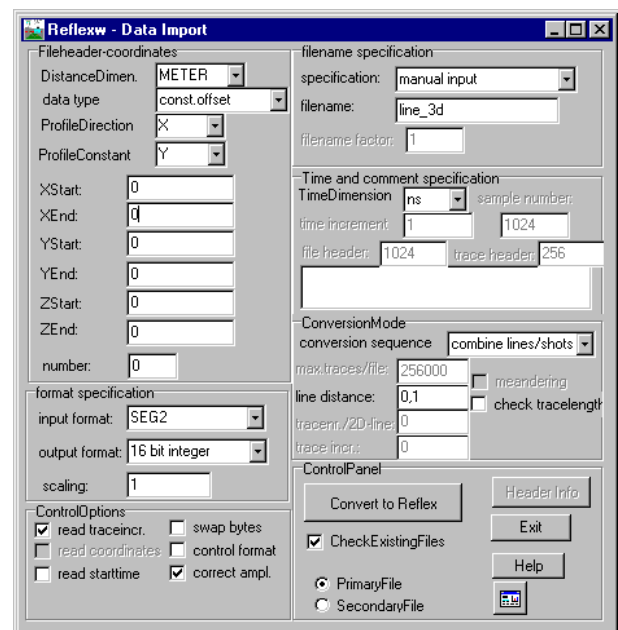
ProfileConstant: constant coordinate direction of the original 2D-lines (enter either y or x depending on the chosen profile direction)

xstart: start coordinate in x-direction

ystart: start coordinate in y-direction

xend, yend, zstart, zend: not necessary to input

outputformat: 16 bit integer (e.g. for GPR-data) or 32



bit floating point for a higher data resolution (e.g. for seismic data).

To be considered for SEG-Y or SEG2-data: the option swap bytes controls if the original data originate from UNIX (activate option) or DOS-machines (deactivate option). If the conversion fails try to change this parameter.

filename specification: manual input

filename: any name (e.g. line_3d)

TimeDimension: ns (GPR data) or ms (seismic data)

conversion sequence: combine lines/shots

linedistance: enter the distance between the individual parallel 2D-lines

4. activate the option **Convert To Reflex**: the wanted shots must be chosen and they are automatically combined into one single datafile containing all the shots.

There are 2 different possibilities of choosing the datafiles:

a.. choose the datafiles from the openfile dialog (multiple choice using the shift or str-key) : all chosen original data files are sorted with ascending order. Problems may occur if the files don't have the same length (e.g. file1, file2,..., file11). In this case a warning message appears.

b. open an external ASCII-filelist with the extension ".lst": the external filelist contains all wanted datafiles in an arbitrary order (one row contains one filename). The datafiles must be stored under the same path like the ASCII-filelist. Example:

TEST__02.sg2

TEST__01.sg2

After having chosen all the wanted datafiles the combined 3D-datafile is displayed using the actual plot settings (see chap. I:3).

I.1.2 Generating a 3D-file from an original 3D-file

In this case it is assumed that the original profile is a 3D-file consisting of parallel 2D-lines with:

- equidistant trace increment
- equal trace number for each 2D-line
- identical start coordinate for each 2D-line
- equidistant distance between the individual 2D-lines.

In the following the individual steps for creating such a 3D-file are described in detail:

1. enter the module **2D-dataanalysis**
2. activate the option **file/import**
3. choose the following options within the **import menu**:

data type: const. offset (version 2) or 3D-const.offset (from version 3)

ProfileDirection: direction of the original 2D-lines (enter either x or y)

ProfileConstant: constant coordinate direction of the original 2D-lines (enter either y or x depending on the chosen profile direction)

xstart: start coordinate in x-direction

ystart: start coordinate in y-direction

xend, yend, zstart, zend: not necessary to input

outputformat: 16 bit integer (e.g. for GPR-data) or 32 bit floating point for a higher data resolution (e.g. for seismic data).

To be considered for SEG-Y or SEG2-data: the option swap bytes controls if the original data originate from UNIX (activate option) or DOS-machines (deactivate option). If the conversion fails try to change this parameter.

filename specification: original name

TimeDimension: ns (GPR data) or ms (seismic data)

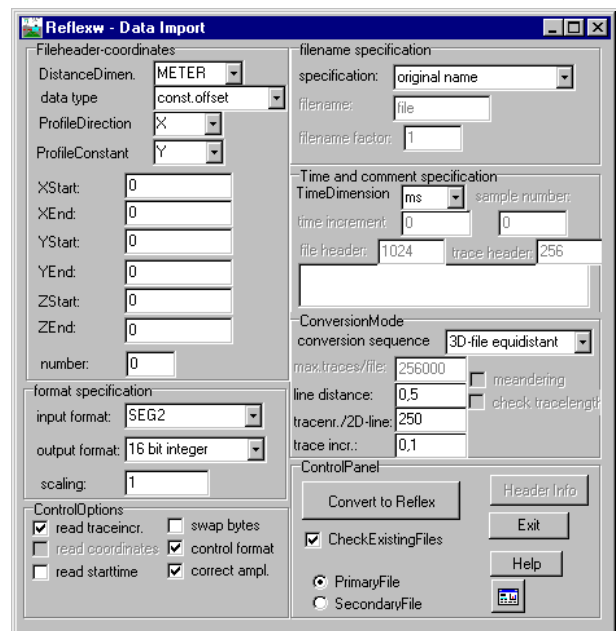
conversion sequence: 3D-file equidistant

linedistance: enter the distance between the individual parallel 2D-lines

tracnr./2D-line: enter the number of traces for each 2D-lines containing within the 3D-file

traceincr.: enter the increment between the traces within each 2D-line

4. activate the option **Convert To Reflex**: the wanted original 3D-file must be chosen. The data within the resulting REFLEXW 3D-datafile are stored in the same manner like the original data but the ensemble number which controls the different 2D-lines is set based on the entered tracnr./2D-line.



I.2 Generating a 3D-file from REFLEXW formatted 2D-lines (done within the 3D-datainterpretation)

A 3D-datafile may also be generated from REFLEXW formatted 2D-lines. The 2D-lines may be raw data (then the processing is done for the 3D-datafile) or already processed data. There are no general rules whether the processing shall be done for the 3D-datafile or for the individual 2D-lines. If only few 2D-lines are present it might be better to do the processing for the 2D-lines.

REFLEXW allows to construct a 3D-datafile either from equidistant parallel 2D-lines without interpolation or from 2D-lines freely orientated within one acquisition plane using a weighted interpolation. In any case the coordinates (start- and endcoordinate in profiledirection and profileconstant coordinate) must have been defined within the fileheader of each 2D-line.

I.2.1 Generating a 3D-file from REFLEXW 2D-lines without interpolation

The preconditions for generating a 3D-file within the 3D-datainterpretation without interpolation are REFLEX formatted 2D-lines with:

- parallel 2D-lines with equidistant profile increment
- equidistant trace increment
- equidistant time increment
- same number of points per trace
- same number of traces per 2D-line

If these preconditions are satisfied you may easily construct a 3D-file without a spatial interpolation:

1. enter the module **3D-datainterpretation**
2. activate the option **file/Generate 3D-file from 2D-files**

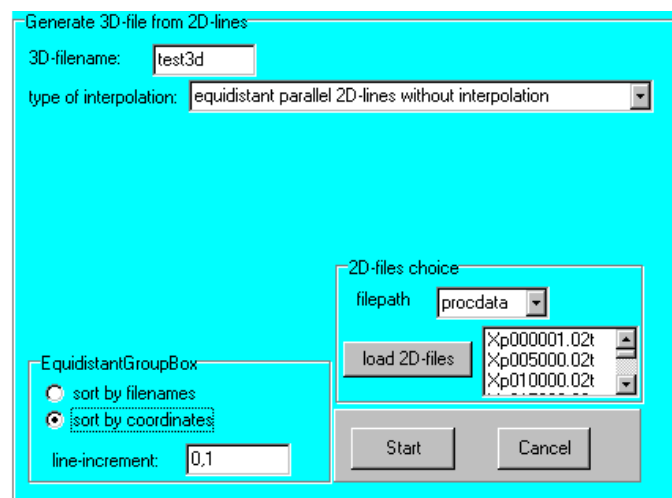
3. choose the following options within the **Generate 3D-file from 2D-lines menu**:

3D-filename: enter any name for the 3D-datafile

type of interpolation: equidistant parallel 2D-lines without interpolation

EquidistantGroupBox:
choose either sort by filenames or sort by coordinates (see item 4)

line-increment: enter the increment between the different 2D-lines



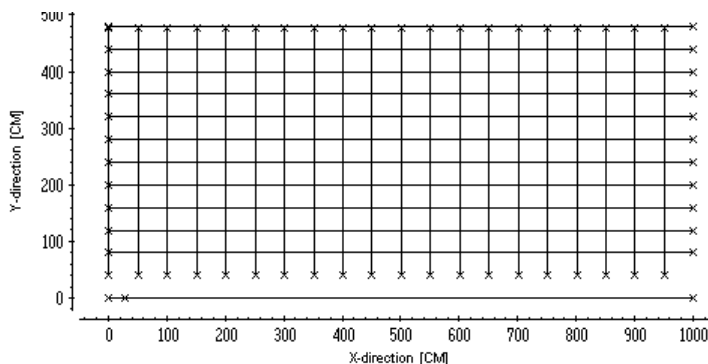
4. choose the wanted **filepath** and activate the option **load 2D-files** in order to choose the wanted 2D-files from the openfile dialog (multiple choice using the shift or str-key). The sorting of the 2D-files depends on the chosen option within the EquidistantGroupBox. With sort by filenames activated all chosen original datafiles are sorted with ascending filename order. To be considered: problems may

occur if the files have names like file1, file2,..., file10, file11. In this case the chosen files are resorted in the following manner: file1, file10, file11, file12, ,file2, which leads to a wrong sorting within the resulting 3D-file. With sort by coordinates activated all chosen original datafiles are sorted with ascending profileconstant coordinates. In this case the profileconstant coordinates must have been defined first within the fileheader.

5. Activating the option **start** starts the generation of the 3D-datafile. The 3D-file is generated without any interpolation. With ProfileDirection set to X and ProfileConstant set to Y the number of points in x-direction is equal the number of traces per 2D-file, the number of points in y-direction is equal the number of 2D-files and the number of points in z-(time-)-direction is equal the number of points per trace. The file will be stored under the path rohdata under the actual project directory. After having created the file the 3D-data are automatically loaded into the RAM (see also chap. III). The 3D-datafile can be processed within the 2D-dataanalysis (see chap. II).

1.2.2 Generating a 3D-file for freely distributed 2D-lines

If the original data are not parallel equidistant lines of constant lengths but they have for example different lengths, different start coordinates or different orientations (e.g. crossing lines - see figure on the right) you may use the interpolation routines within REFLEXW for generating a new 3D-datafile. You may also use the interpolation for parallel equidistant lines (see also chap. I.2.1) if an interpolation is wanted (e.g. if only few 2D-lines exist).



To be considered: The necessary processing (see chap. II) should always be done onto the original 2D-datafiles. Therefore the 3D-datafile should be generated based on the completely processed 2D-datafiles.

1. enter the module **3D-datainterpretation**

2. activate the option **file/Generate 3D-file from 2D-files**

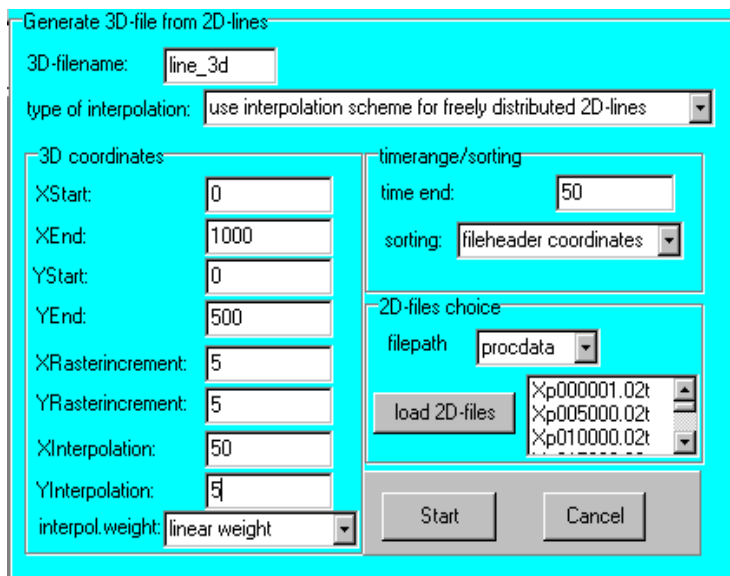
3. choose the following options within the **Generate 3D-file from 2D-lines** menu:

3D-filename: enter any name for the 3D-datafile

type of interpolation: use interpolation scheme for freely distributed 2D-lines

3D coordinates group box :

XStart, XEnd, YStart and YEnd: specify the range coordinates within the dataacquisition



plane for the computation of the 3D-data cube.

XRasterincrement and YRasterincrement: specify the grid interval of the two coordinate axes spanning the plane in the given distance dimension. A useful value for both XRasterincrement and YRasterincrement is the traceincrement used for the individual 2D-profiles.

XInterpolation and YInterpolation: define the interpolation area (a rectangle) in the given distance dimension. To guarantee a complete filing of the 3D-data cube the interpolation range in x- and y-direction has to comply with the greatest occurring distance between two data points in the corresponding direction whereby a too large range leads to an averaging.

interpol.weight: allows to specify the type of the interpolation weight.

timerange/sorting group box :

time end: specifies the timerange for the 3D-data cube. The time always starts at 0.

sorting: determines the sorting of the profiles entering the computation of the time slices. Four different sortings are possible: fileheader coordinates or geophone coordinates, midpoint coordinates and CMP coordinates (defined within the individual traceheaders).

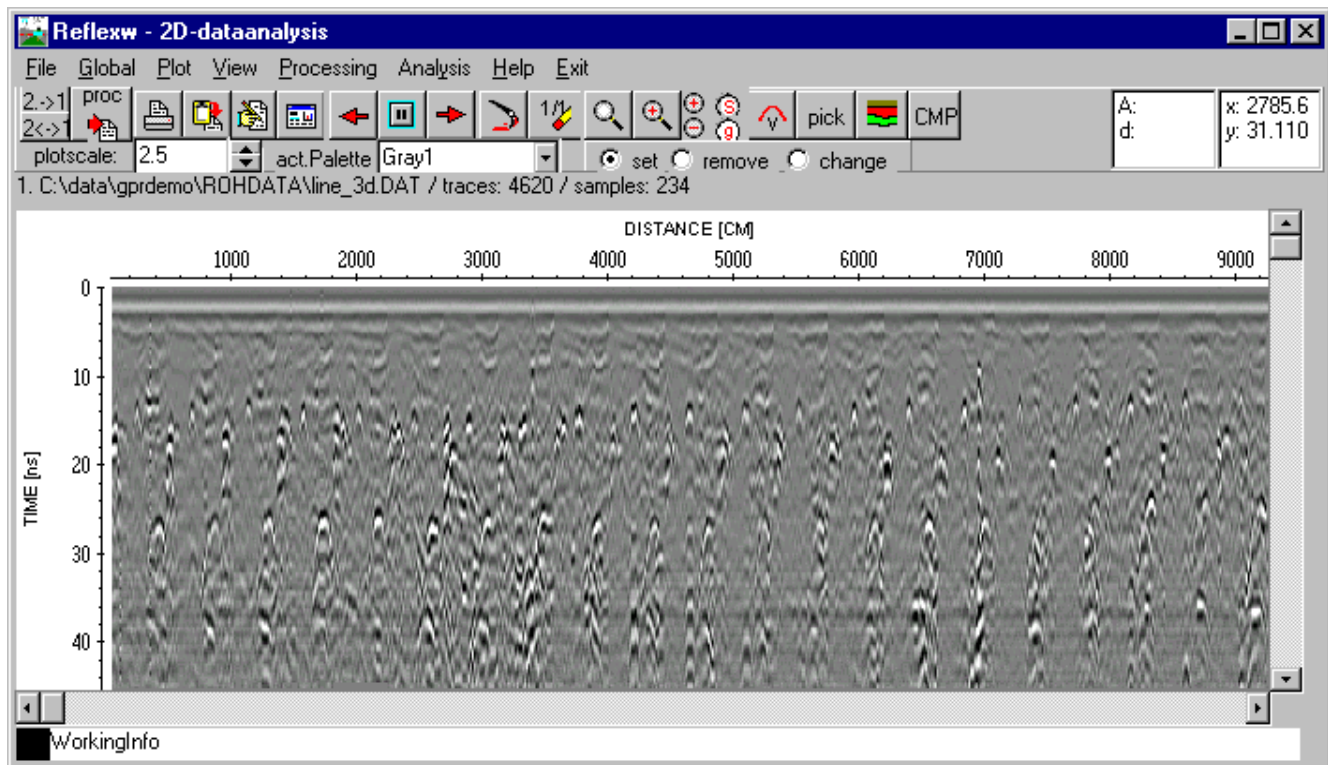
4. choose the wanted **filepath** and activate the option **load 2D-files** in order to choose the wanted 2D-files from the openfile dialog (multiple choice using the shift or str-key).

5. Activating the option **start** starts the generation of the 3D-datafile. The number of datapoints depends on the entered range of the 3D-cube and the raster increments. To ensure, that the resulting 3D-file does not exceed the max. size of 1024^3 points, the parameters XRasterincrement and YRasterincrement can be enlarged and/or the volume of the data to be considered can be reduced. The file will be stored under the path rohdata under the actual project directory. After having created the file the 3D-data are automatically loaded into the RAM (see also chap. III). The 3D-datafile can be processed within the 2D-dataanalysis (see chap. II).

I.3 resulting REFLEXW 3D-datafile

The resulting 3D-file has the same REFLEXW format like a 2D-datafile and may be processed within the 2D-dataanalysis module (chap. II) whereby the interpretation must be done within the 3D-datainterpretation (chap. III).

The different 2D-lines are stored sequentially. The distance axis within the 2D-dataanalysis represents the distance sum over all 2D-lines. Because of the normally huge number of traces and the chosen plotmode (Pointmode, XYScaledPlot) the screen display resolution may be too small to plot the data correctly (XScale too small). In this case choose the Zoom-option in order to only display a small part of the data in x-direction.



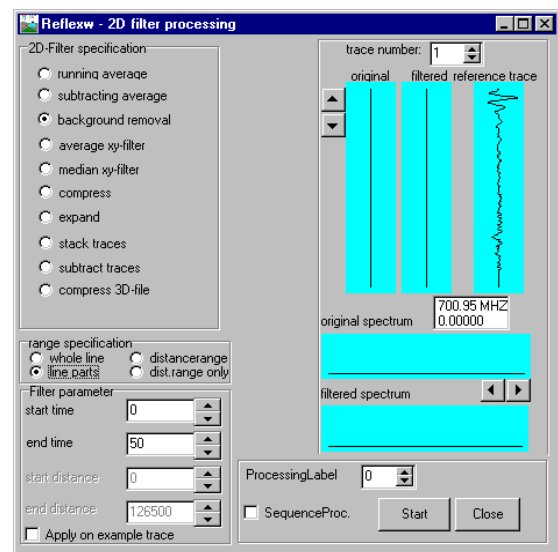
To be considered: If only few 2D-lines have been acquired with a large number of traces the resulting 3D-datafile may have many points in one direction and very few in the other. In this case it might be better to use the interpolation method for generating a 3D-datafile from REFLEXW formatted 2D-lines (see chap. I.2.2) especially if you want to display timeslices. Although it is clear that the resolution will not be enhanced the timeslices may appear more reasonable by the averaging of the interpolation.

II. processing a 3D-data file (done within the 2D-dataanalysis)

A **3D-data file** is a single REFLEX formatted file which consists of several equidistant 2D-cuts sequentially stored. All traces belonging to one 2D-cut have the same ensemble-number which is stored within the REFLEXW traceheader. The direction (x or y) within the fileheader determines the direction of the 2D-cuts.

A 3D-data file may be processed like any 2D-file (see for example filtering guide) but there are some peculiarities to be considered for:

1. If the 3D-datafile is generated by an interpolation (chap. I.2) the complete processing should be always applied onto the original 2D-datafiles.
2. If the data contain hyperbolas from small scale objects or from pipes a migration is necessary in addition if timeslices are used for the interpretation (see also chap. III).
3. The processing step static correction is very important because the same time baseline must be used for all 2D-cuts. Otherwise the timeslices are not correct.
4. multichannel filters like background removal or fk-filter: the option **line parts** should be activated. In this case the distance range for applying the filter is automatically determined for line parts (individual 2D-cuts) separated by each other by a new ensemble number.



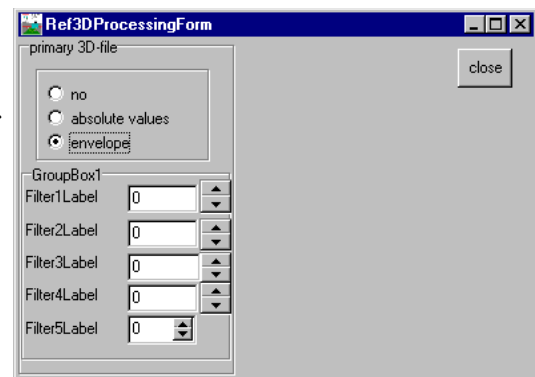
III. interpretation of a 3D-data file (done within the 3D-datainterpretation)

The module 3D data-interpretation allows the interpretation of 3-dimensional data by displaying x-, y- or z-slices or the full 3D-data volume.

The data are completely loaded into the RAM of the computer whereby a fast visualization of the data is possible. The max. number of points in each direction (x-cuts, y-cuts and z-(time)cuts) is 1024. Three different display options are available (option windows, option scroll and option 3D-cube - see below).

III.1 load a 3D-datafile

1. enter the **3D-datainterpretation**
2. load the 3D-datafile using the option **File/Open 3D-file**
3. After having chosen the wanted 3D-file the Ref3DProcessingForm menu opens which allows you to define the internal processing of the 3D-file. Use **envelope** if you want to display timeslices. Use **no** if you want to interpret x- or y-cuts.
4. activate the option **close** and the chosen 3D-file is loaded into the RAM.
5. The internal processing may be changed at a later stage using the option **processing**.

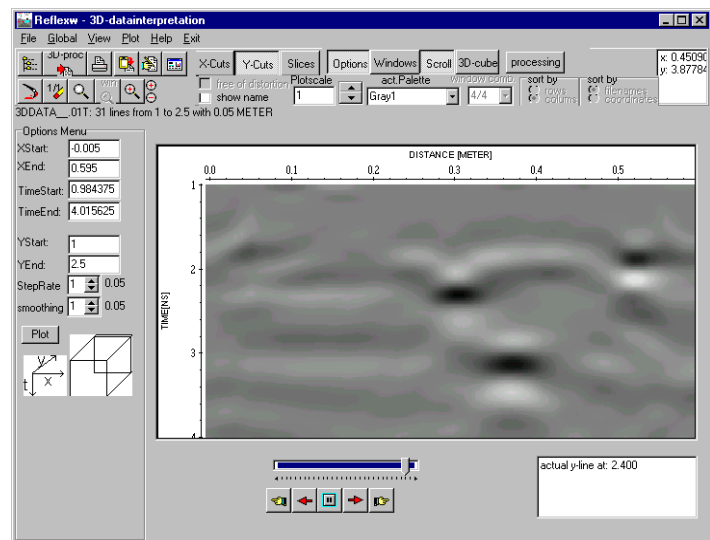


III.2 display a 3D-datafile using the scroll option

1. after having loaded a 3D-datafile activate the option **scroll**
2. Activating one of the three different **cuts** (X-Cuts, Y-Cuts or Slices) allows to scroll through the 3D-daticube into the given direction using the scroll bar or the arrows.

3. The coordinate parameters within the Options Menu are automatically set. The option StepRate allows you to change step rate for scrolling. Every step range 2D-cut will be plotted when scrolling.

The option smoothing allows to enter a value for smoothing the data in the scroll direction. A value of 1 means no smoothing. A value of 2 means that 2D-cuts are summed up and the mean values are calculated. The smoothing parameter is independent from the StepRate parameter.

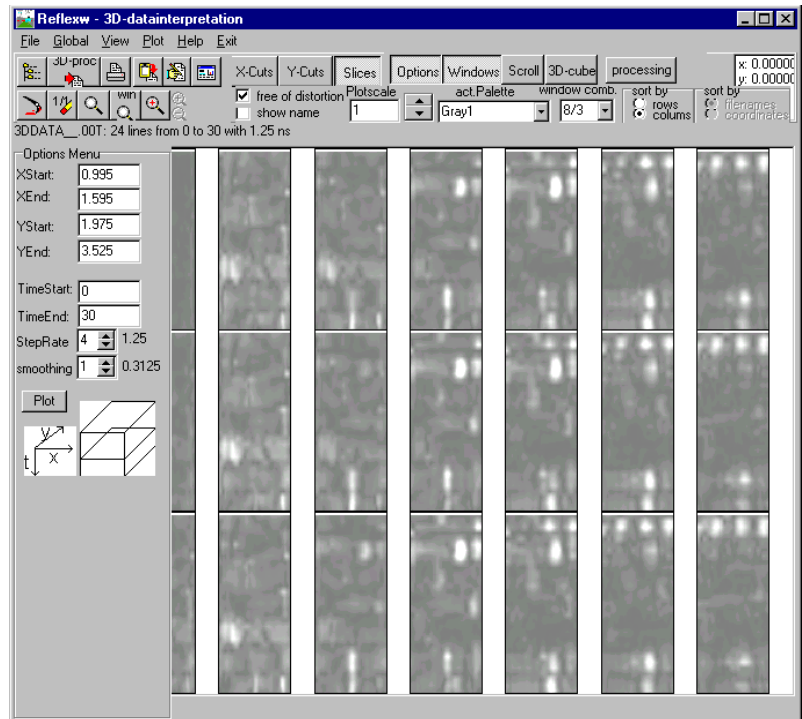


III.3 display a 3D-datafile using the windows option

1. after having loaded a 3D-datafile activate the option **windows**
2. Activating one of the three different **cuts** (X-Cuts, Y-Cuts or Slices) allows to display several 2D-cuts of the 3D-cube, placed in freely choosable manner within the working window.

3. The **coordinate** parameters within the Options Menu are automatically set. The max. number of cuts to be displayed simultaneously is 25. The program automatically calculates the StepRate for the given cut range (in this example TimeStart and TimeEnd) and calculates the increment (this example 1.25 ns). You may manually change these parameters.

4. The option **window comb.** allows to choose the combination of the windows to be subdivided in horizontal and vertical direction. the possible combinations are automatically predefined. If you have 24 different cuts to be displayed you may choose the combination 8/3 - this means the screen is subdivided into 8 horizontal and 3 vertical cuts.



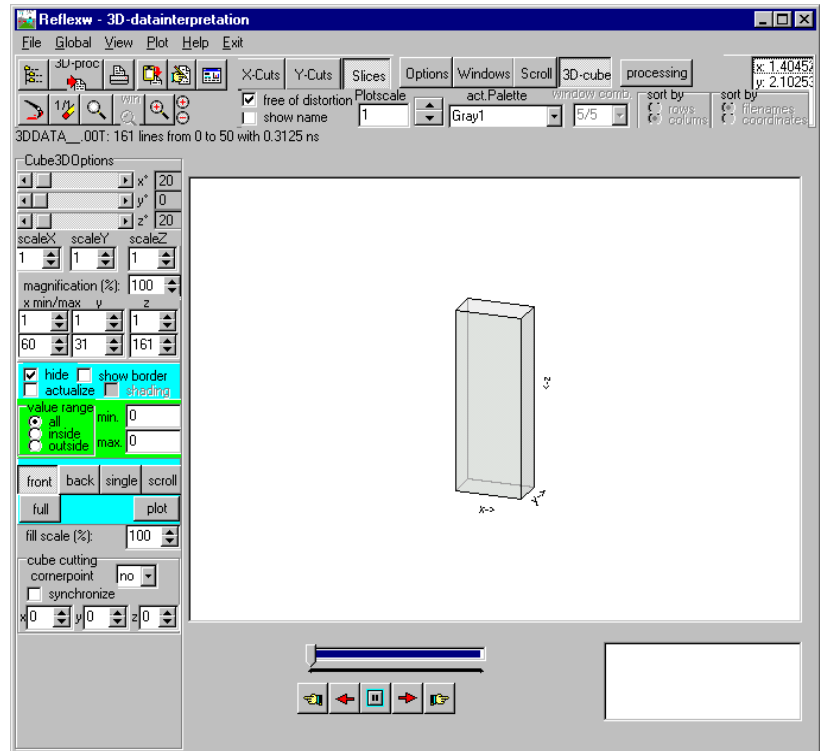
5. The option **Options** can be deactivated. In this case the OptionsMenu disappears and the full screen is visible.

III.4 display a 3D-datafile using the 3D-cube option

1. after having loaded a 3D-datafile activate the option **3D-cube**

2. The 3D-cube will be displayed together with the Cube3DOptions menu.

3. The **size** of the 3D-cube is determined from the number of the points into the different directions x, y and z(time). The point numbers are displayed within the options min/max for x, y and z. Here you also may restrict the range. The axis scales of the 3D-cube are based on these values and do not correspond to the real coordinates. This may significantly differ for example if the 3D-datafile has been created without interpolation (traceincrement and lineincrement differ significantly). It is possible to change the axis scales using the options **ScaleX**, **ScaleY** and **ScaleZ**.



4. You have the possibility to look at the cube from different angles, e.g. from the front side, the back side or from the side. The angles can be changed manually within the options x/, y/ and z/ or using the mouse with pressed left mouse button within the 3D-cube display.

5. You have different display possibilities. You may select if only the front or back planes of the data cube are displayed (options **front** and **back**) or the full 3D-data volume (option **full**). In addition you only may select single cuts (option **single**) and scroll (option **scroll**) through the cube in one distinct direction.