Computer Simulation of fluid flow, heat flow, chemical reaction and stresses in solids

WinPHOTON User Guide

Content

1. **Introduction**

1.1   What WinPHOTON is and does

WinPHOTON is a post-processor used to visualize results of calculations produced by PHOENICS. WinPHOTON possesses all the functionality of its predecessor, PHOTON; but it differs in that it exploits the graphic possibilities offered by the operating system (Windows, Xwindow, LINUX/UNIX), thus providing a more modern interface for users.

The reader of this document is presumed to be familiar with the main relevant features of PHOTON, namely that:
- PHOENICS places the results of its calculation in a file called (by default) phi; but other (4-character) names may be used.
- If a body-fitted grid was used, it places the cell-corner co-ordinates in a file called (by default) xyz, but other 4-character names may be used.
- PHOENICS places information about the boundary-condition-setting patches which it has used in a file called PATGEO.
- PHOTON, when first started, looks for a file called u; and, if it exists, obeys the commands which it contains.
- If PHOTON finds in u the command: 'use filename', it looks for a file called 'filename' and executes the commands contained in it.

The commands in question include:
- gr   , to show the grid
- con   , to show contours
- vec   , to show vectors
- sur   , to show iso-surfaces.

There are, of course, qualifications for each command, for example:
- on which plane (ix = ? , iy = ?, iz = ?) are the images to be displayed? [PHOTON cannot select arbitrary planes].
- should contours be represented by lines or by colour gradations?
- what should be the size of the vectors?
- what should be the value of which the iso-surface should be drawn?

While users work with dialog windows, internally the program executes the usual array of PHOTON commands which, generated in sequence, provide the needed result. With just a few mouse clicks, users are able to produce graphic images of calculation results.

Although WinPHOTON differs visually from PHOTON, it embodies many of its features:
- Commands may be entered manually to create drawings and set parameters, the commands being almost the same as for PHOTON;
- When WinPHOTON is run, it records commands entered during the session into a file called PHOLOG. This file is written in USE-file format, which can be read by WinPHOTON to recreate the session at a later date.
- WinPHOTON is integrated with AUTOPLOT into a single program;

1.2   Features of WinPHOTON

Features of WinPHOTON can be classified as:
- Interface features;
- Function features;
- Settings features.

Interface features include:
- Separate windows for *entering information* and for *drawing*. The program draws figures in the main window; but users enter commands and see program messages in a dialog window, namely the *Command Console*;
- WinPHOTON contains a standard menu interface and a set of dialog windows;
- Help and Tutorial use the Internet browser installed in the default operating system.

WinPHOTON has many function features not possessed by PHOTON including the ability to allow users to:
- save, in a file, a drawn Figure as a set of commands;
- edit the USE-file while running the program;
- use any fonts installed in the operating system to create TEXT objects;
- change the order of object drawing;
- change the number of colours in the palette from 16 to 256 to draw CONTOUR objects and smooth images;
- edit parameters for almost all types of objects (GRID, TEXT, CONTOUR and others);
- delete any object from a list, (not only the last object as was the case in PHOTON);
- show boundaries of cut-cell control volumes if PARSOL is used for calculations;
- see results of calculations as graphical images and as tables of values for each field variable;
- create new macro-variables, assign values to them, use formulae for determination and apply them in a processing package;
- create a new field variable and use formulae for its determination or use calculated field variables and macro-variables. After creating new field variables, users can apply them to all methods of processing as for the usual variables calculated from PHI files;
- view the sequence of results for transient cases without editing the USE-file in animated mode and as a slide show.

WinPHOTON has new settings features for the user interface so that users can:
- set the colours of the background of drawing area, the default font, main lines and background of outside area;
- set the sequence of object drawing for various types: GRID, CONTOUR, TEXT etc.

1.3   Parameters of the environment

WinPHOTON is part of PHOENICS. It should be installed on the same hard-drive partition as other PHOENICS modules; otherwise, it will not work.

For WinPHOTON to work successfully, it is necessary to check files:
`/phoenics/d_allpro/cham.ini` and `/phoenics/d_photon/coldat`.

The file `/phoenics/d_allpro/cham.ini` should contain the section `[F-array];` and this section should contain line `PHOTON = 32768`. This is the recommended value of F-array size, although users may change it. However, WinPHOTON will allocate memory dynamically as it reads PHI-data; therefore this value influences the working of AUTOPLOT only.

The file `/phoenics/d_photon/phocon` must contain the line:
`50;  pbcl.dat ;PARSOL data to be read; 98; 2; 1;  80`
This is necessary for calculations involving PARSOL.

WinPHOTON saves all executed commands into a file called `pholog`, located in the current working directory. These are: commands entered by users, commands from USE-file and commands generated by dialog windows.

AUTOPLOT saves all executed commands into the file `autlog`, located in the current working directory.

1.4   On-line Help and Tutorial

PHOTON has a Help facility which users can access from the main menu or from the *Command Console* window. Typing '?' in the *Command Console* brings up help information in an Explorer window.

WinPHOTON has a Tutorial which users can start from the main menu. It describes what users must do to learn the main features of the program.

1.5   About this Guide

This document contains a description of the User interface and information about the commands for WinPHOTON. More detailed information about WinPHOTON commands and AUTOPLOT can be found in the Help facility.

This User Manual consists of an Introduction and three further chapters. Chapter 2 contains a general description of the program interface, the main window and the *Command Console*. Chapter 3 describes how to use WinPHOTON; and Chapter 4 describes how to use AUTOPLOT.

2.   **General View**

This chapter contains information on the general structure of WinPHOTON.

2.1   Main Window and Main Menu

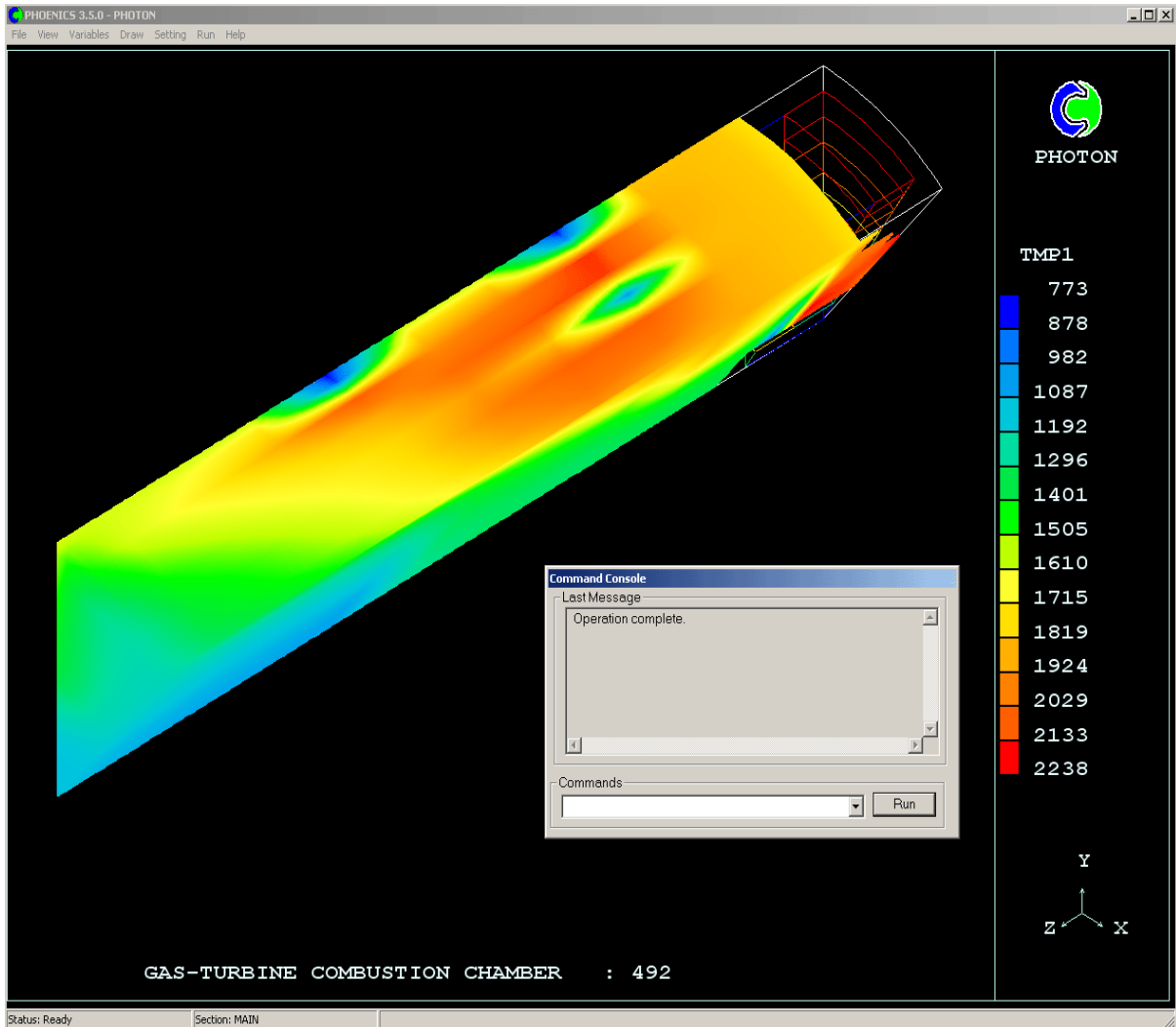A view of the main WinPHOTON window, while running a case, is shown in Fig 2.1.

Figure 2.1

The main window contains the menu at the top, the status line at the bottom, the drawing area in the centre and the *Command Console* window (see 2.1.2).

The status line has three sections. Users can see whether the program is ready to have data entered in first section (*Status*). The second section contains information as to which part of the program is running at the current time (*Section*). The third section is seldom used but could, for example, indicate the cursor position.

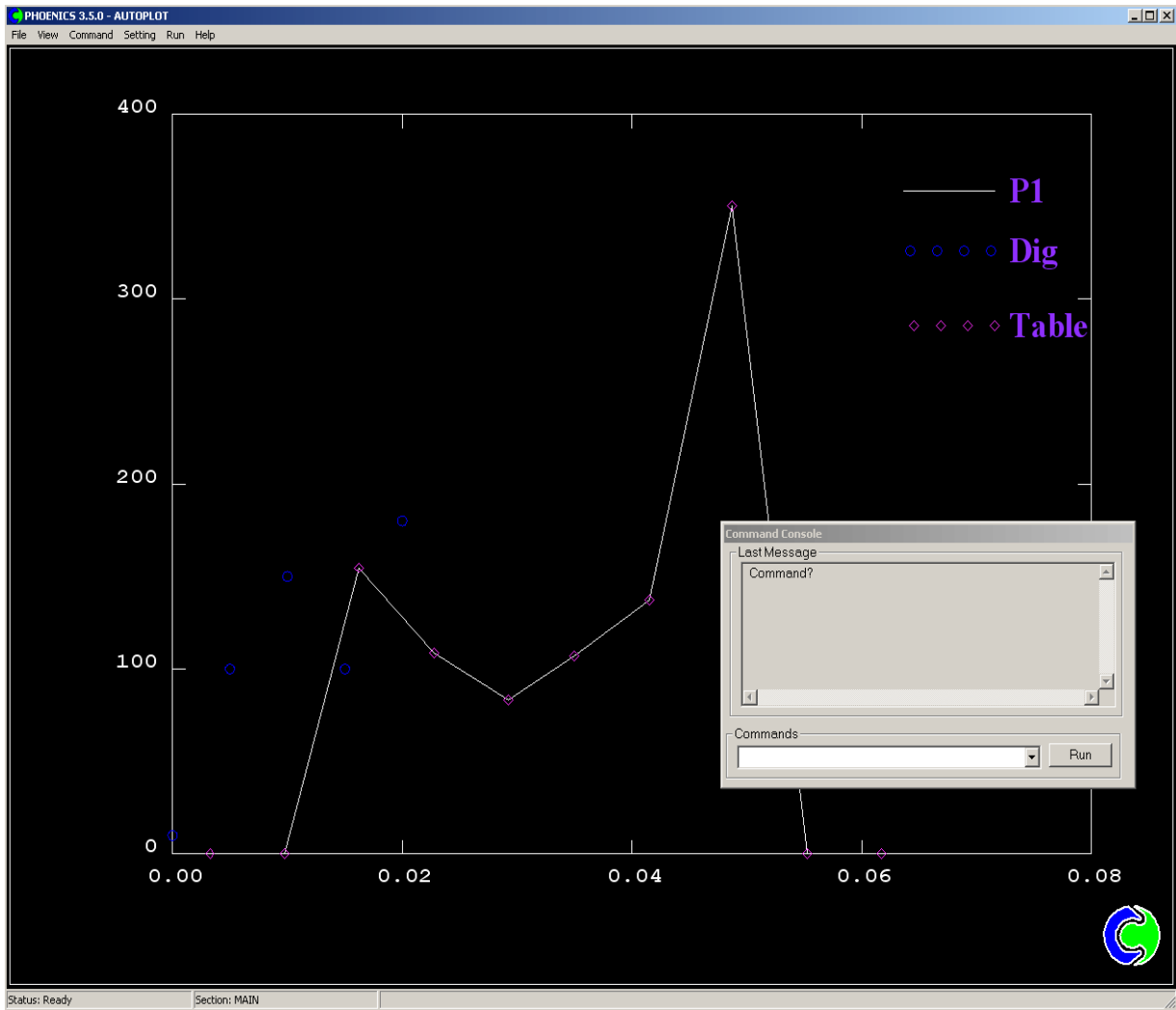A view of the main AUTOPLOT window, while running a case, is shown in Figure 2.2.

Figure 2.2

2.1.1   Menu of WinPHOTON
The WinPHOTON menu has the following structure:

File Submenu

Submenus	Description	Comments
Open PHI/XYZ File	Opens dialog to select file type, set scales and activate opening mode (with Extrapolation or without).	See 3.1.1
Open Use file	Opens dialog to select USE-file.	See 3.1.2
Open PATGEO file	Opens dialog to select file *PATGEO*.	See 3.1.3
Save Windows As	Opens the standard window of the operating system to enter name of files to save graphic information. Users can save graphic files in two formats – GIF or PCX. The program saves graphic information of the drawing area from an internal buffer (not from the screen) therefore saved information does not depend on the *Command Console*. Users will not see *Command Console* on the saved Figure. Background colour is determined by parameter `PCX_Background` from section `[FTN386]` of file `/phoenics/ d_allpro/cham.ini`.	

Print Window	Opens standard operating system window to print the graphical view from drawing area. Background colour is determined by parameter `PCX_Background` from section `[FTN386]` of file `/phoenics/ d_allpro/cham.ini`.	
Exit	If users select this item, the program will terminate immediately, without finishing the drawing of a complex Figure.	

View Submenu

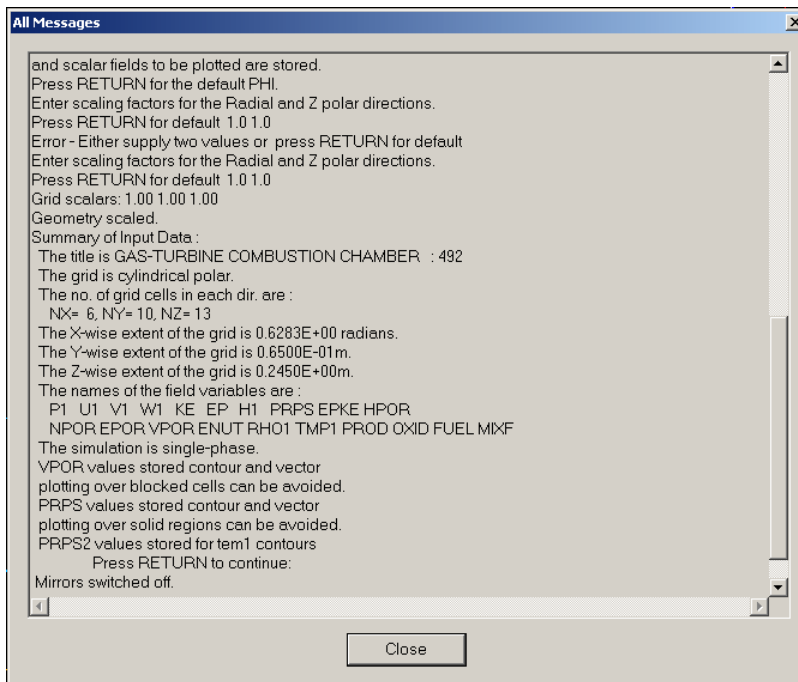| Submenus	Description	Comments
Show Console	Useful for showing and hiding the *Command Console* window; it is selected by users.	
Show command…	Contains submenus: *Variables, Grids, Vectors, Contours, Surfaces, Stream, Text, Blocks, and Geometry*. Selection of any of them generates the command SHOW (for example, SHOW VARIABLE). Users will see the result of command execution in the *Command Console* window.	
View direction	Opens *View Direction* dialog, enabling users to change UP direction, angles of axes in space, zoom and other.	See 3.3.1
All messages	Opens window *All messages*, which shows to the users all messages from window *Command Console*.	

Window *All messages* shown on Figure 2.3

Figure 2.3

Variables Submenu

Submenus	Description	Comments
PHI Variables	Opens window *Select Variables* containing list of field variables.	See 3.4.2
Macro Variables	Opens window *Macro Variables* containing list of macro-variables.	See 3.4.1
Look of Variables	Opens window *Select Variables* to select field variable to see calculated values as table.	See 3.4.3

Draw Submenu

Submenus	Description	Comments
Clear	Generates command CLEAR	
Redraw All	Generates command REDRAW	
Grids	Opens window containing list of *GRID* objects.	See 3.2.1
Contour	Opens window containing list of *CONTOUR* objects.	See 3.2.2
Vector	Opens window containing list of *VECTOR* objects.	See 3.2.3
Surface	Opens window containing list of *SURFACE* objects.	See 3.2.4
Stream Line	Opens window containing list of *STREAM LINE* objects.	See 3.2.5
Text	Opens window containing list of *TEXT* objects.	See 3.2.6
Save drawing Command	Opens standard window of the operating system to enter names of files to save sets of commands and create *GRIDS, VECTORS*, *CONTOURS* and *SURFACES* created by users at the current time.	
Transience	Opens window to view results of transient cases	See 3.5

Settings Submenu

Submenus	Description	Comments
Set params	Opens window to set some parameters.	See 3.3.2
Set colours	Opens window to set colours of general elements.	See 3.3.3
Plotting order	Opens window to set order of drawing objects on screen.	See 3.3.4

Run Submenu to run AUTOPLOT.

Help Submenu

Submenus	Description	Comments
Contents	Opens main page of Help in default html-browser.	
Tutorial	Opens main page of Tutorial in default html-browser.	
About	Opens window containing program version data.	

2.1.2 AUTOPLOT Menu
The AUTOPLOT Menu is structured as follows:

File Submenu

Submenus	Description	Comments
Data files	Opens dialog, which contains the list of opened files.	See 3.1.1
Open use file	Opens dialog to select of USE-file.	See 3.1.2
Save Windows As	Opens standard window of the operating system to enter names of files to save graphic information. Users can save graphic files in two formats – GIF or PCX. The program saves graphic information off the drawing area from an internal buffer (not from screen) therefore saved information does not depend on placement of the *Command Console*. Users will not see the *Command Console* on the saved Figure.	
Exit	If users select this item, the program will terminate immediately, without finishing the drawing of a complex Figure.	

View Submenu

Submenus	Description	Comments
Show Console	Useful for showing or hiding the *Command Console* window.	
Show command…	Contains submenus: *Text, Keys, Groups* and *Files.* Selection of any of them generates the command SHOW (for example, SHOW TEXT). Users will see the result of command execution in the *Command Console* window*.*	
All messages	Opens window *All messages*, which shows users all messages from window *Command Console.*	

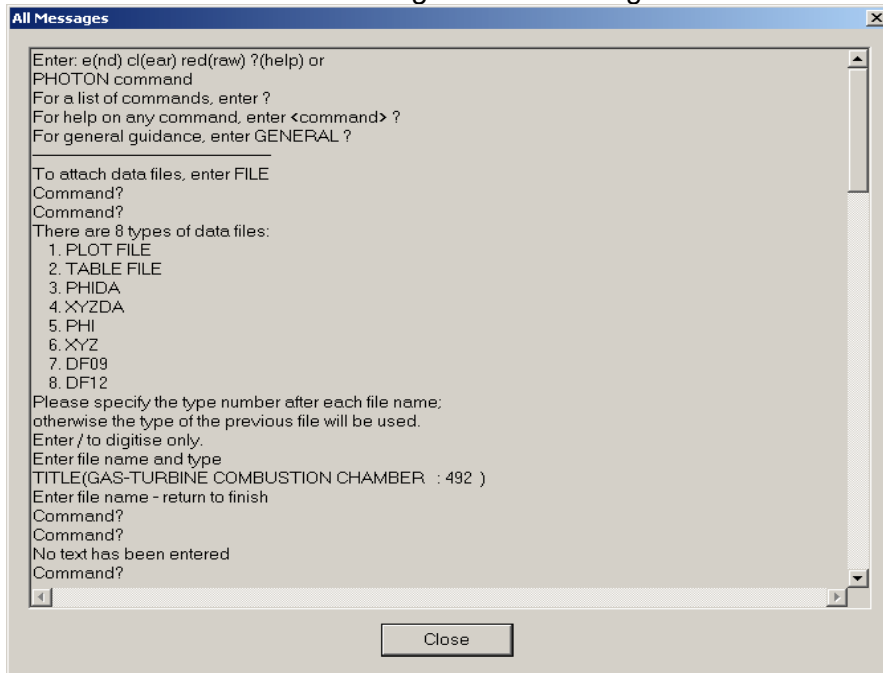Window *All messages* shown on Figure 2.4

Figure 2.4

Command Submenu

Submenus	Description	Comments
Redraw	Generates the command REDRAW	
Clear	Generates the command CLEAR	
Datas	Opens window containing the list of *DATA* objects for graphic drawing.	See 4.2
Texts	Opens window containing the list of *TEXT* objects.	See 4.3.1
Levels	Opens window containing the list of *LEVEL* objects.	See 4.3.2

Settings Submenu

Submenus	Description	Comments
Set colours	Opens window to set colours of general elements of main window.	See 4.4.1
Keep parameters	Opens window to set types of objects which will be saved after execution of command CLEAR.	See 4.4.2
Scale	Opens window to set parameters of command SCALE.	See 4.4.3
Grid	Opens window to set parameters of command GRID.	See 4.4.4

Run Submenu to run WINPHOTON.

Help Submenu

Submenus	Description	Comments
Contents	Opens main page of AUTOPLOT Help in default html-browser.	
About	Opens window containing program version data.	

2.2   Command Console

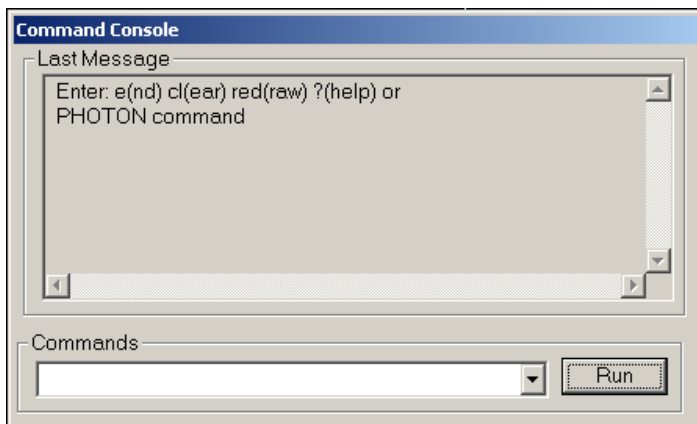The general view of the window *Command Console* is shown in Figure 2.5

Figure 2.5

The field *Last Message* on top is for program messages. It provides information for users resulting from the last command entered, information about errors and so on.

The field *Commands* contains the *Run* button and a box for entering commands. The latter also provides a pull-down list to see previously-entered commands. The box has the *Code Completion* propert*y*.

3. **WinPHOTON Interface**

3.1 Open files

After starting WinPHOTON, users should open the file which contains the results of the calculation. Its default name is `PHI`; but other, 4-character, names may be used. Alternatively, users can open a so-called USE file containing the commands `PHI` or `EXTRAPOLATION`, which also serve to open data files.

3.1.1 Open PHI file

To open the file, users can select menu item *File->Open PHI/XYZ file*. The dialog window *Open PHI/XYZ file* will be opened. The window is shown in Figure 3.1.
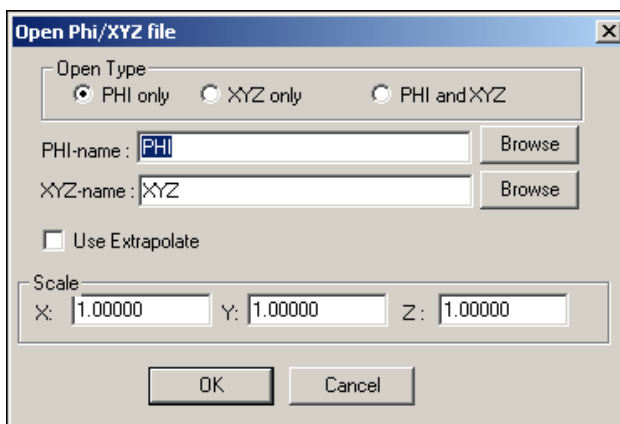

Figure 3.1

Users can select a file from any directory on the hard drive via the *Browse* button near the input field *PHI-name*.

If necessary users can change scales on axes X, Y and Z.

It a case has been run with a body-fitted-co-ordinate (BFC) grid, it is necessary to open file `XYZ` as well as file `PHI`. File `XYZ` saves geometry data about curvilinear grids.

`XYZ` can be given another name.

If users check box *Use Extrapolate,* two control volumes will be added to all boundaries of the calculation area which allows the creation of objects (CONTOURS, VECTORS, etc) on the whole surface of the calculation area and not only on internal centres of control volumes. NOTE: if *Use Extrapolate* is chosen, the number of control volumes will be increased by two in each direction.

Command sequences will be generated and executed by using the *OK* button. These commands will open files and set scales.

3.1.2 Open USE file

Users can prepare and execute a 'macro' file containing a set of commands (the so-called USE file). For this purpose, users should select menu item *File->Open Photon Use file*. A dialog window *Open Use file* will be opened as shown in Figure 3.2.
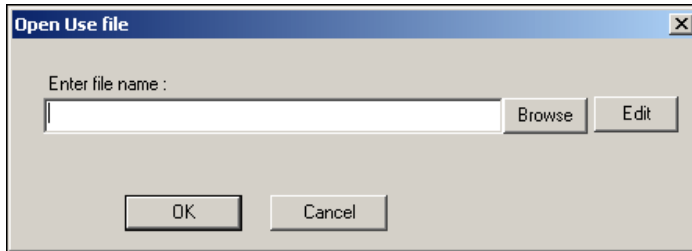
Figure 3.2

Users can search for files on the hard drive via the *Browse* button. To create a new file, or edit an existing file, use the *Edit* button; the program notepad.exe will be started and WinPHOTON will be blocked. Users can change the USE file and save the changed variant. Once users exit from notepad.exe, WinPHOTON will continue. WARNING: if users save changes into a new file, it must be selected by the *Browse* button before pressing *OK*.

After pressing *OK,* USE mode starts command-by-command. Once USE mode has started, the following command is generated:

```
USE <directory>\<use-file>
```

Users can cancel USE mode via the BREAK command in *Console Command*.

3.1.3   Open file PATGEO

Sometimes users need to see the geometry of objects. For this purpose, file patgeo must be opened using menu item *File->Open Patgeo file*. Dialog window *Open PATGEO file* will open as shown in Figure 3.3.
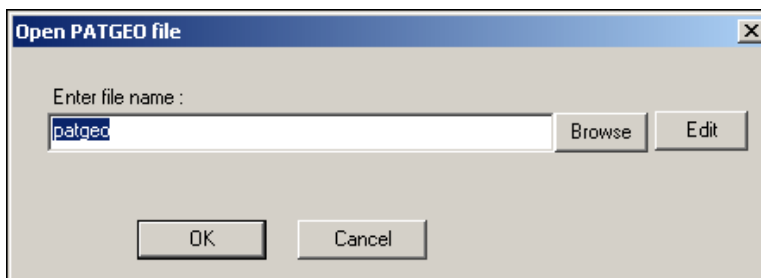

Figure 3.3

Working in this window has the same functionality as working in the *Open Use file* described in 3.1.2. The *OK* button generates the command

```
USE <directory>\patgeo
```

3.2   Drawing operations

Before drawing objects, users should open file PHI or file XYZ.

The interface for creating drawing objects contains two dialog windows: the first lists objects and the second contains the interface for changing object parameters.

3.2.1   Drawing Grids

To create a *GRID* drawing element, users should select menu item *Draw->Grids*. The window *Grid Objects* containing a list of existing objects will open as shown in Figure 3.4.
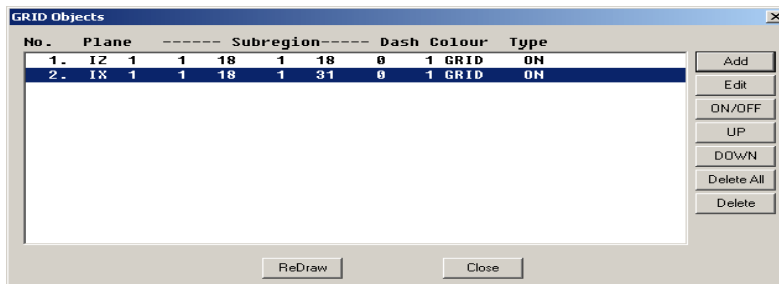
Figure 3.4

The window contains an object list from which users can:
- select any object and use edit (via the *Edit* button),
- change its visibility (*ON/OFF* button),
- move it up or down (*UP* and *DOWN* buttons) and
- delete (*Delete* button).

The order in which the objects are described is the order in which they are drawn on the screen. Users can change this order via the *UP* and *DOWN* buttons, which may be important when drawing contour planes which can hide previous drawings. Users can delete all objects by using the *Delete All* button

There are *ReDraw* and *Close* buttons at the bottom of window. *ReDraw* executes the REDRAW command which redraws all active drawing objects on screen. This is useful when users have edited objects and want to see the change without closing the window. *Close* closes the window and generates the command REDRAW.

To create new objects, users can use the *Add* button. Window *Grid Command* will open as shown in Figure 3.5
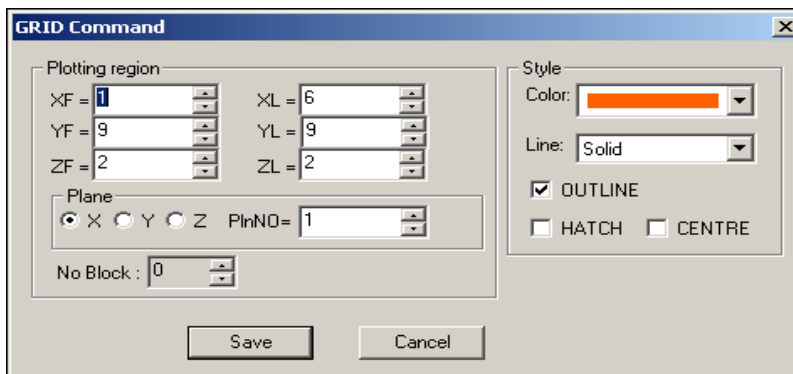

Figure 3.5

This window controls the extent of the grid drawn on the screen. In the above example, the grid is plotted in the first x plane. The grid will be drawn in solid red lines outlining the cell. Users may set attributes for the object: colour and type of line etc. For Multi-Block cases the block number must also be set.

The *Save* button generates the command GRID or MGRID for multi-block model), for example: GRID CENT Z   1 X   1 18 Y   1 18 COL   1 DASH 0

Objects are plotted in the main window and added to the list in window *Grid Objects*.

If users want to change object parameters, this must be done via the *Edit* button in window *Grid Objects* and in the *Grid Command* window.

3.2.2 Contour Drawing

To create a *CONTOUR* drawing element, users should select menu item *Draw-> Contour*. The window *CONTOUR Objects* containing a list of objects opens as shown in Figure 3.6.
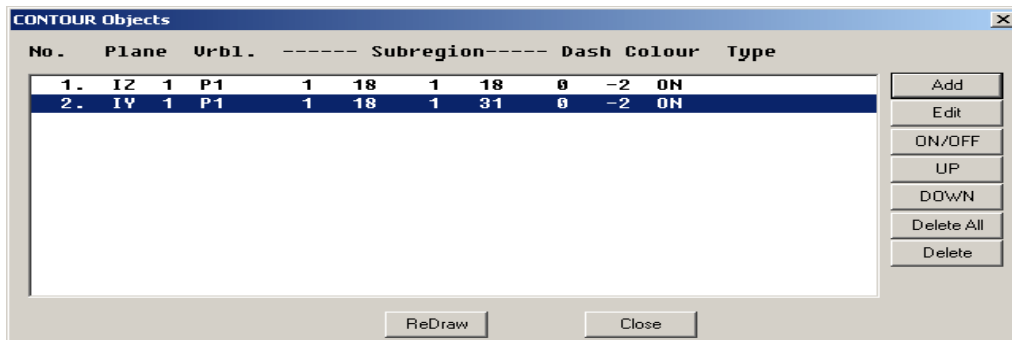

Figure 3.6

The window contains a list of objects. Users can select any one and undertake any of the following actions:

- edit (via the *Edit* button),
- change visibility (*ON/OFF* button),
- move up or down in the list (*UP* and *DOWN* buttons),
- delete (*Delete* button).

Changing the position in the list changes the order of plotting on screen so that the object list corresponds to the drawing order on screen. Users can delete all objects by using the *Delete All* button

There are *ReDraw* and *Close* buttons at the bottom of window. *ReDraw* executes REDRAW, a command which redraws all active drawing objects on screen. This is useful when users have edited objects and want to see the change without closing the window. *Close* closes the window and generates the command REDRAW.

To create a new object, users use the *Add* button. Window *CONTOUR Command* will be opened as shown in Figure 3.7
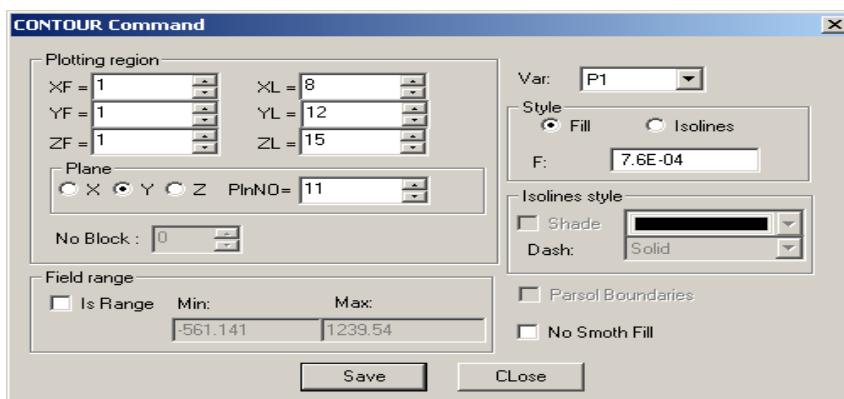

Figure 3.7

Using this window, users can set object parameters:
- numbers of first and last control volumes in a direction perpendicular to selected plane;
- direction of normal to plane of object being created;
- number of planes.

Users may choose to colour-fill the contour regions or draw isolines at contour intervals. If users select colour filling, the Fineness parameter can be set. If this value is small, the drawing time can be long. Conversely, if the value is large the drawing is done quickly, but image quality may be poor.

If users decide to draw using isolines, the number and type of isolines must be set. If *Shade* is not checked, a selected colour will be used for drawing; otherwise isolines will have various colours. Users can also set the type of isoline (*Solid* or *Dash*).

Users can set the number of blocks for object creation for a multi-block model.

If users wish to restrict the range of variable values for object creation this can be done by using the box *Is Range* to set maximum and minimum values of variable.

If PARSOL is used in calculations and *Parsol Boundaries* is checked, a new variable *PSC will be created which mark the boundaries of cut-cells and enables them to be seen.

In some cases, for example to create contours for variables PRPS or RHO, it is acceptable to see "non-smooth" contours. Users can use *No Smooth Fill;* then the image will lack smoothing and each control volume will have its own single colour.

Save generates command `CONTOUR` (or `MCONTOUR` for multi-block model), for example:
CONTOUR P1 Y 9 X 1 18 Z 1 31 FILL; -8.00E+00 4.00E+00 ; 8.00E-04

The object will be plotted in the main window and added to the list in window *CONTOUR Objects*.

If users want to change object parameters, this must be done via the *Edit* button in window CONTOUR *Objects* and in the CONTOUR *Command* window.

3.2.3   Vector Drawing

To create a *VECTOR* drawing element, select menu item *Draw-> Vector*. The window *VECTOR Objects,* containing a list of objects, will open as shown in Figure 3.8.
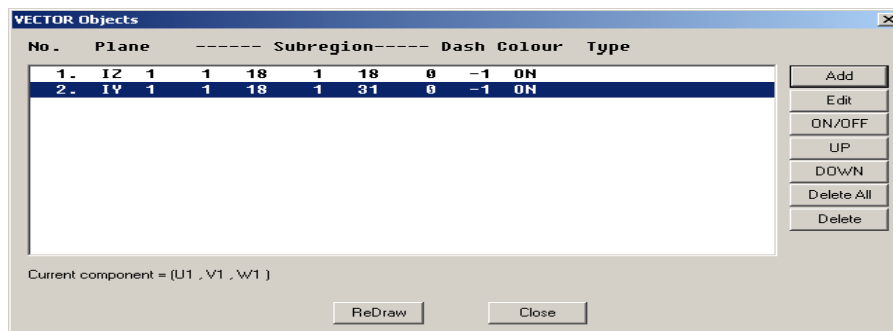

Figure 3.8

Users can select any object from those listed and:
- edit (*Edit* button),
- change visibility (*ON/OFF* button),
- move up or down in list (*UP* and *DOWN* buttons),
- delete (*Delete* button).

The object list corresponds to the drawing order on screen. Users can delete all objects by using the *Delete All* button

There are *ReDraw* and *Close* buttons at the bottom of window. *ReDraw* executes the `REDRAW,` command which redraws all active drawing objects on screen. This is useful when

users have edited objects and want to see the change without closing the window. *Close* closes the window and generates the command `REDRAW`.

The *Add* button opens window *VECTOR Command* (Figure 3.9) to create a new object.
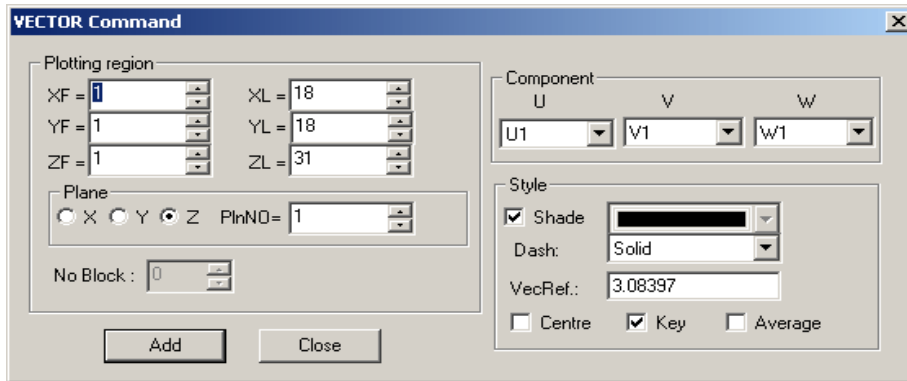

Figure 3.9

Users can set object parameters via this window:
- numbers of first and last control volumes in a direction perpendicular to selected plane;
- direction of normal to plane of object being created;
- number of planes.

Users can also set object attributes:
- names of variables for components of velocity,
- relative length of vector,
- method of forming the colour of lines,
- type of line and so on.

If the calculation is made for a multi-block model, users must set the number of blocks for creating the object.

The *Save* button generates a set of commands, for example:
```
SET VEC COMP U1 V1 W1
SET VEC CENTRE OFF
SET VEC KEY ON
SET VEC REFERENCE 3.08397
VECT Z   1 X   1  18 Y   1  18  SH DASH 0
```

This presets object parameters and creation. The object will be plotted in the main window and the new object will appear in the object list in window *VECTOR Objects*.

Users can change object parameters via the *Edit* button in window *VECTOR Objects* and in the *VECTOR Command* window.

3.2.4 Surface Drawing

To create a *SURFACE* drawing element, users select menu item *Draw-> Surface*. The window *SURFACE Objects* containing a list of objects opens as shown in Figure 3.10.
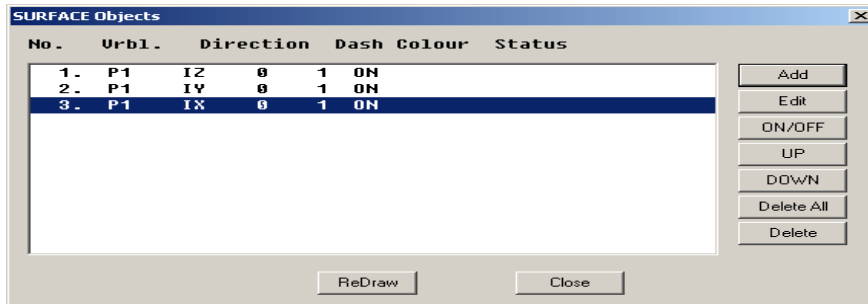


```
SURFACE Objects                                          [x]

No.   Urbl.   Direction  Dash Colour  Status
  1.  P1     IZ      0      1   ON                      Add
  2.  P1     IY      0      1   ON                      Edit
  3.  P1     IX      0      1   ON                     ON/OFF
                                                        UP
                                                       DOWN
                                                     Delete All
                                                      Delete

              ReDraw              Close
```

Figure 3.10

Users can select any object from the list shown and:
- edit (*Edit* button),
- change visibility (*ON/OFF* button),
- move up or down in list (*UP* and *DOWN* buttons),
- delete (*Delete* button).

The object list corresponds to the drawing order on screen. Users can delete all objects by using the *Delete All* button

There are *ReDraw* and *Close* buttons at the bottom of window. *ReDraw* executes the REDRAW, command which redraws all active drawing objects on screen. This is useful when users have edited objects and want to see the change without closing the window. *Close* closes the window and generates the command REDRAW.

New objects are created via the *Add* button. Window *SURFACE Command* will open as shown in Figure 3.11.


```
SURFACE Command                              [x]

Var:  [P1      ▼]    ─Plane─    ─Lines style─
                      ⊙ X       Color:
─Field value─         ○ Y       [████████ ▼]
Value : [0.00000]     ○ Z       Dash:
Min:    [1239.54]               [Solid   ▼]
Max:    [-561.141]

           Save          CLose
```
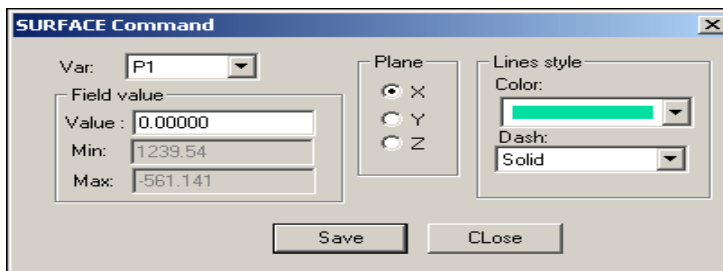
Figure 3.11

Using this window, users can set object parameters:
- variable for object creation,
- value of variable,
- plane,
- colour and type of lines.

The *Save* button generates command SURFACE, for example:
```
SURFACE P1 Z  COL   1 DASH 0 -2.48E+00
```
The object will be plotted on the main window and the new object will appear in the object list in window *SURFACE Objects.*

Users can change object parameters via the *Edit* button in window *SURFACE Objects* and in window *SURFACE Command*.

3.2.5   Stream-Line Drawing
To create a *STREAMLINE* drawing element, select menu item *Draw-> StreamLines*. The window *STREAMLINES Objects* containing an object list opens as shown in Figure 3.12.
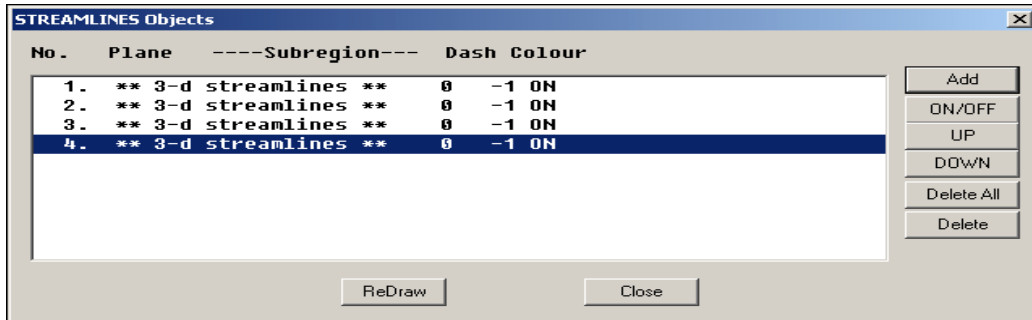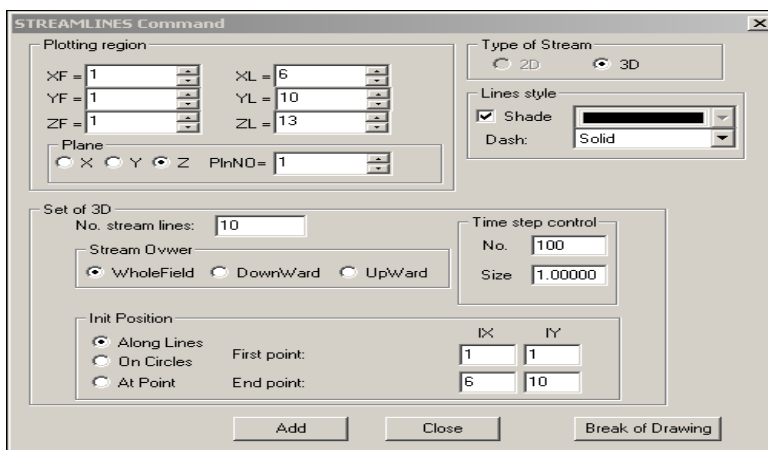

Figure 3.12

Users can select any object from the list shown and:
- edit (*Edit* button),
- change visibility (*ON/OFF* button),
- move up or down in list (*UP* and *DOWN* buttons),
- delete (*Delete* button).

The object list corresponds to the drawing order on screen. Users can delete all objects by using the *Delete All* button.

There are *ReDraw* and *Close* buttons at the bottom of window. *ReDraw* executes the REDRAW command which redraws all active drawing objects on screen. This is useful when users have edited objects and want to see the change without closing the window. *Close* shuts the window and generates the command REDRAW.

A new object is created via the *Add* button; and the *STREAMLINES Command* window will open as shown in Figure 3.13.

Figure 3.13

Using this window, users can set object parameters, initial conditions, determine trajectories of test particles moving with flow and numerical parameters for calculation of trajectories. Object parameters are similar to other drawing elements:
- numbers of first and last control volumes in a direction perpendicular to selected plane;
- direction of normal to plane of object being created;
- number of planes.
- Users can set object attributes: colour, type of line etc.

Users can set the number of trajectories for:
- calculation,
- calculation method:
- whole field,
- downward or upward.

It is necessary to set numeric parameters:
- time step,
- number.

Initial conditions can be set:
- from an initial point along line determined from start point to end point,
- from points on circle
- from the start point.

The *Add* button starts calculating trajectories of test particles, for example:

```
STREAM 3D Z   1 X    1  18 Y   1  18  SH DASH 0
YES
WHOLEFIELD
STEPS;  100
TIME;1.000E+00
PO
-1
     1     1
    18    18
    10
T
EXIT
    10
```

Calculations begin from the start of a line of points and continue to the domain exit. If trajectories cannot exit the domain, because of flow features, and calculations are too lengthy, users can terminate calculations via the *Break of Drawing* button. The calculation will terminate but an object will be created as part of trajectory calculated to time of termination. The object will be plotted in the main window and will appear in the object list in window *STREAMLINE Objects*. Unlike other object types, *STREAMLINE* objects cannot be edited. Users can delete and re-create with other parameters.

3.2.6   Text Element Drawing

To create a *TEXT* drawing element, select menu item *Draw-> Text;* then the window *List of text elements* (containing a list of objects) opens as shown in Figure 3.14.
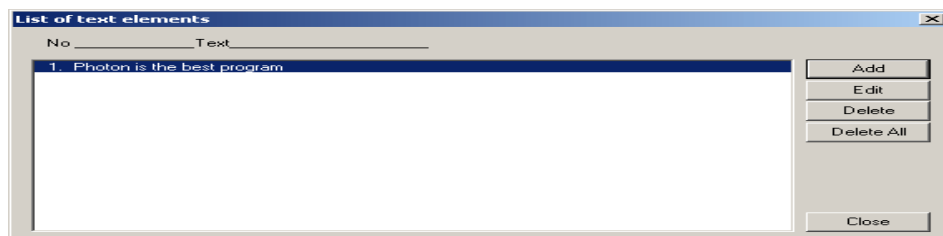

Figure 3.14

Users can select any object from the list shown and edit (*Edit* button), delete (*Delete* button) or delete all objects (*Delete All* button).

The *Close* button shuts the window and generates the command REDRAW.

New objects are created via the *Add* button. Window *Add and Edit Text Element* opens as shown in Figure 3.15.
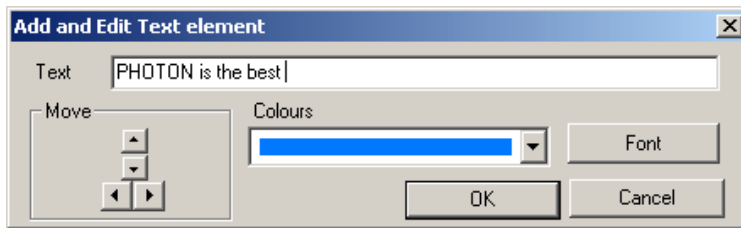

Figure 3.15

Using this window, users can:
- set object parameters,
- enter text,
- set the font of text,
- select text colour from box *Colours* (not from standard window of font parameters).

WINPHOTON always draws TEXT objects on the main window therefore users can see all changes and move text on screen using arrows.

The *OK* button does not generate commands but the object will be plotted in the main window and will appear in the object list in window *List of text elements*.

Object parameters can be changed via the *Edit* button in the window *List of text elements*. When object parameters are changed, users can see images of the object, both saved and changed, in the main window

3.3   Settings

Users can change most parameter settings of WinPHOTON by entering commands SET in the *Command Console* window. For some commands, dialog windows are available.

3.3.1   View Direction
Users may wish to change view direction and view point, to use zoom, to change direction UP etc. To set the view point select menu item *View->View Direction*. The window *View dialog* opens and, at this point, WinPHOTON changes to special drawing mode so that, in the main window, users see only domain boundaries and GRID objects. Figure 3.16 shows the main window and Figure 3.17 the *View dialog* window.
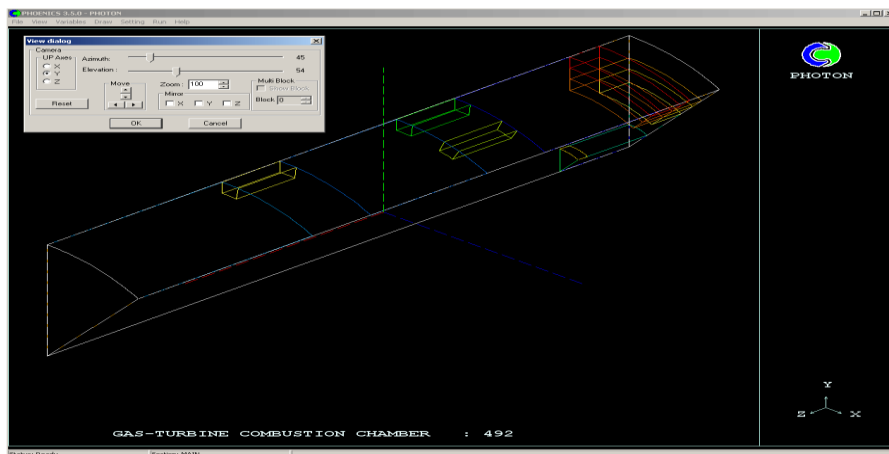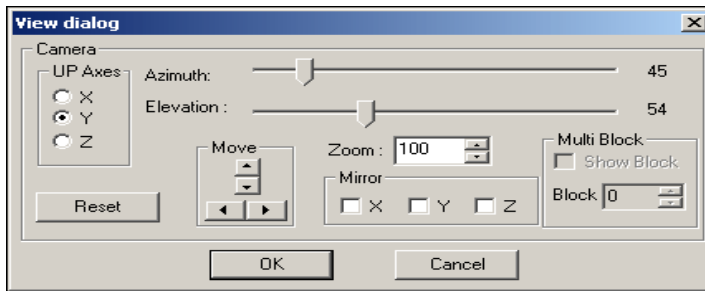

Figure 3.16

Figure 3.17

Axes can be seen in the main window:
- X – blue line,
- Y – green line,
- Z – red line.

Users can change the UP direction by selecting one of three axes on the left of the window, changing the angles of the view direction relative to the axes and moving the scrolling *Azimuth* and/or *Elevation* by using arrows in area *Move*. If users check *Mirror* then, after the dialog window is closed, mirror images are created relative to selected directions. Users can zoom by using UP and DOWN arrows near field *Zoom*. Users can edit *Zoom*, but the size will change only after pressing on arrows.

If users calculate using the multi-block model, *Show Block* will show the geometry of each block separately by changing the block number. The geometry of all blocks may be seen if the number of blocks is set to zero.

To reset previous view direction and other parameters, use the *Reset* button

The *OK* button generates a set of commands to save changes, for example:
```
VIEW   7.28E-01   5.77E-01  -3.71E-01
UP  0.00E+00   1.00E+00   0.00E+00
MIRROR X
REDRAW
```
The final command is generated when it is necessary to redraw all objects.

3.3.2 Setting Parameters
WinPHOTON uses many parameters when drawing objects. Users can change parameters via command `SET <parameter>` [1]. For some changes users can select menu item *Setting->Set params* and window *SET commands* opens as shown in Figure 3.18.
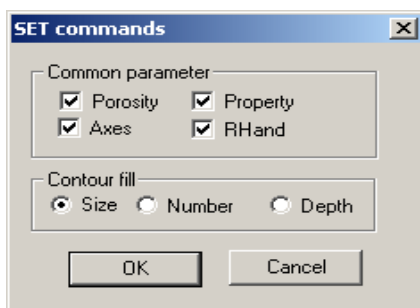

Figure 3.18

Use of the *OK* button ensures that only necessary commands will be generated connected to User changes. For example:
```
SET CON FILL NUMBER
SET AXES OFF
SET LHAND
```

3.3.3 Setting Colours

Menu item *Setting->Set Colours* changes the colours of the main elements in the main window; the *Colours* window opens as shown in Figure 3.19.
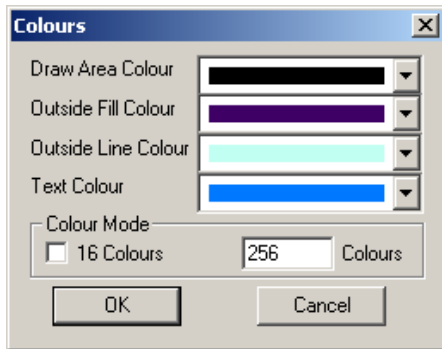

Figure 3.19

Users can change the following colours:
- background of drawing area,
- background of outside area,
- lines
- default text

by selecting colour from a preset palette.

Users can set the number of colours for drawing *CONTOURS* and *VECTORS*. If the standard 16-colour palette is selected via *16 Colours*, *CONTOUR* colours will have clear-cut boundaries.   Users can set an arbitrary number of colours in range from 16 to 256 by unchecking *16 Colours* and setting the needed number of colours. There will be no qualitative change to the colour palette; but the *CONTOUR* images will be smoother.

Values of selected colours will be saved in file `phoenics/d_allpro/coldat` via the *OK* button. The `REDRAW` command will be generated; and, when WinPHOTON restarts, all colours set by users will be restored.

3.3.4 Setting Plotting Order

Users may need to change the drawing order for various types of objects. This can be done via menu item *Setting->Plotting order*. The window *Plotting order* opens as shown in Figure 3.20.
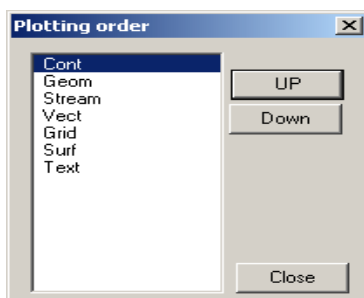

Figure 3.20

Users can select the order of drawing objects via *UP* and *DOWN* buttons

When WinPHOTON terminates, the order of drawn objects is not saved; therefore users should set the drawing order of objects at the start of the program.

3.4   Macro Variables and Field Variables

WinPHOTON users have the possibility of recording a set of commands in USE files (see 3.1.2). When preparing USE files, it is necessary to create new variables to save useful information. These are called macro-variables and can have numerical values (integer or real); or they can be string variables (up to 80 characters). During the processing of USE files their current values will be used.

WinPHOTON users can change the number of variables by adding new field variables and deleting calculated ones. For example, if users calculate hydrodynamic flow, and wish to calculate local values of kinetic energy of flow, new variables can be added and calculated via pre-set formulae. Users can include in formulae:
- calculated field variables,
- macro-variables,
- internal functions,
- arithmetic operations
- constants.

All variables can have an image created.

When working with macro-variables and field variables, users can use two internal constants:
```
PI = 3,141593
E  = 2,718282
```
users should adhere to the following rules in formulae:
- use pair parenthesis "2.*(3.+4.)";
- use operation "*", "/", "+", "-" and "^" for power;
- use the next functions: 'ATAN', 'COS', 'SIN', 'TAN', 'ABS','EXP', 'LN', 'LOG', 'SQRT'(square root), 'SQR' (square), 'INT'(rounding-off), 'FRAC' (remainder = Arg-REAL(INT(Arg))), 'TRUNC'(integer part), 'ASIN', 'ACOS', 'SIGN'(sign of argument);
- use less than 80 characters for commands;
- use parenthesis for power operation after multiplication or division;
- multiply by (-1) to change the sign of argument;

3.4.1   Macro Variables
Users must use new commands of WinPHOTON for work with macro-variables:
```
MACro INTeger <list of variables>
MACro REAL <list of variables>
MACro CHAR <list of variables>
```
Users can use assignment operation for macro-variable, for example:
```
Macro Integer N
Macro real R
Mac char S
N = :NX: + :NY: + :NZ:
R = PI/3.0
S = A:N:.dat
```

Macro-variables NX, NY and NZ are determined by the results of calculations. As a result of execution, the set of command the string S depend on amount of control volumes of all directions.??? Users can use macro-variables with other WinPHOTON commands, for example:
```
Macro real FI
FI = 1.e-4
con TEMP iy M fi;:FI:
```

The following commands were created to work with macro-variables:

`Macro CLEar` - to delete all macro-variables (besides NX, NY, NZ);

`MACro DELete <list of variables>` - to delete macro-variables from list;

`MACro RECalc` – to recalculate all macro-variable.

To work with macro-variables, users select menu item *Variables-> Macro Variables.* The window *Macro Variables* opens as shown in Figure 3.21.
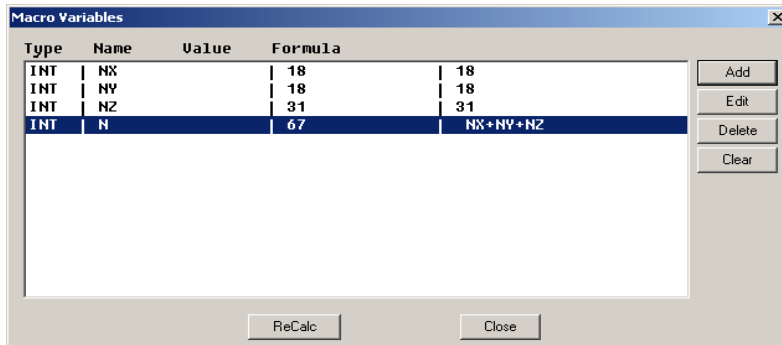

Figure 3.21

Users can select from the list and:
- edit formula-determined macro-variables (*Edit* button),
- delete any macro-variable (*Delete* button),
- delete all macro-variables (*Clear* button),
- recalculate all macro-variable (*ReCalc* button).

New macro-variables can be created via the *Add* button. The *Macro Variables* window will open as shown in Figure 3.22.
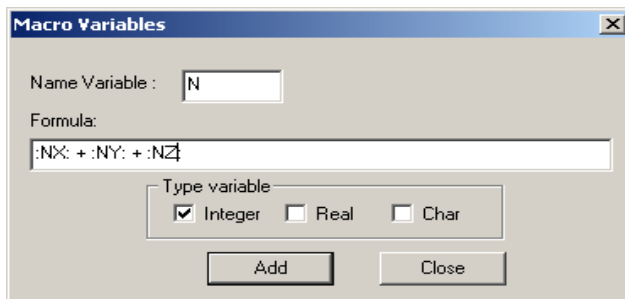
Figure 3.22

Users can enter:
- a unique name for a new macro-variable,
- formula for its determination,
- select the type of macro-variable,
- use the *Add* button.

If a mistake occurs, a message will appear in the *Command Console*.

The *Macro Variables* window can be closed only by pressing the *Close* button; users will see all created macro-variables listed, with their values.

3.4.2 Field Variables

To work with new field variables, users can use the WinPHOTON command:

ADDVAR <name of variable> is <formula>

For example

`ADDVAR EX is U1^2`

In dialog mode, users select menu item *Variables-> PHI Variables and the PHI Variables window opens as* shown in Figure 3.23.
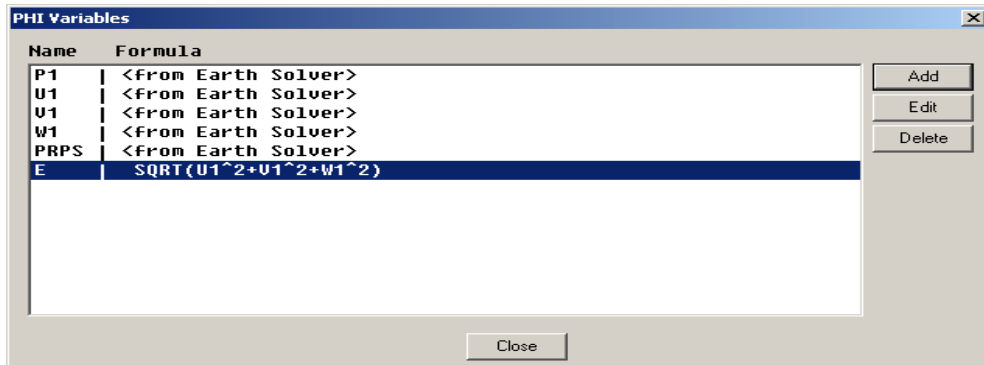

Figure 3.23

With field variables, users can carry out the following operations:
* add new variable (button *Add*),
* edit formulas for variables,
* delete variables as created by users or calculated by solver Earth.

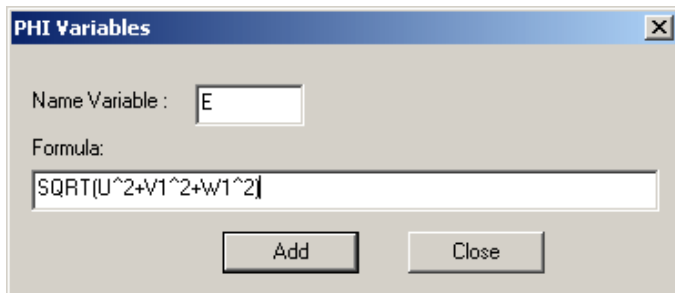New variables can be created via the *Add* button and the *PHI Variables* window will open as shown in Figure 3.24.

Figure 3.24

Users can enter a unique name for a new field variable and a formula for its determination. The formula can contain identifiers of other field variables (created by users or calculated by Earth), macro-variables, pre-defined variables X, Y and Z, denoted coordinates and constants.

If an error occurs, a message appears in the *Command Console*. The *PHI Variables* window can be closed via the *Close* button; users will see all created macro-variables listed with their values.

3.4.3 Inspect PHI Variables
WinPHOTON is intended to display results graphically; however it can also enable users to inspect numerical values.

To do so, users select menu item *Variables-> Look of Variable*; then the *Select Variables* window opens as shown in Figure 3.25.
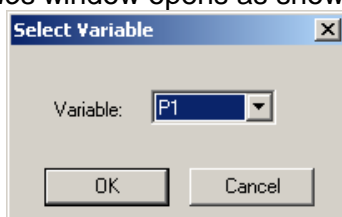

Figure 3.25

After selecting the variable users should press *OK*. The window *Variable: <name of variable>* opens as shown in Figure 3.26.

IZ/IY=	1	3	5	7	9
1	0	154,7	83,25	137,3	0
2	0	130,7	-57,01	233,5	802,5
3	0	-561,1	170,3	238,2	830,1
4	300,7	107,2	-108,2	40,44	672,2
5	165,4	54,69	-100,1	-140,2	168,8
6	234,3	137,6	16,63	0,2678	102,9
7	523,8	461,4	371,5	333,9	407,1
8	517,8	461,9	361,3	246,1	126,8
9	489,8	401	309,1	250,9	227,8
10	750,9	624,7	306	116,6	325,6
11	361,8	248,4	42,45	-86,36	-89,5
12	216,5	116,9	31,44	-12,42	42,82
13	-1,153	-0,04418	0,01528	0,0279	0,04491

Figure 3.26

Users can select a plane (direction of normal and number) to view values of variables; and they can change step values plotted in the table on screen. Users can also change the font and format of values using icons on the top panel. To close the window, users press the green tick.

3.5   Transient cases

WinPHOTON makes it possible to view calculation results for transient cases. When non-stationary processes are calculated, sets of files named `<prefix>No` are usually created, where `<prefix>` - characters, `No` –number of file.

Users can create USE-file, containing sets of commands for drawing images on one time step. This can be done very simply by:
- opening a file of a non-stationary processes,
- creating the necessary set of objects,
- selecting menu item *Draw-> Save of drawing commands*.

A standard systems window to allow file selection will open. The USE-file will contain commands set view direction, UP direction and commands for creation of objects GRIDS, CONTOURS, VECTORS, SURFACES. It is possible to save images; this is useful in cases where it is necessary to build similar images for similar calculation results. After the USE-file is created, it is possible to demonstrate the non-stationary process.

Users can use a WinPHOTON command:
- `TRANSience <prefix> NoBeg NoEnd NoStep <USE_file> trWait [<Work Directory>]`   where `TRANSience` – name of command;
- `NoBeg NoEnd NoStep` – number of first file, number of last file and step of file number accordingly;
- `<USE_file>` -   name of USE-file without path;
- `trWait` –   delay time in milliseconds, if `trWait = -1` then animation will be stopped after each frame and users could press *RUN* in the *Command Console* window;
- `[<Work Directory>]` –   directory with files of calculation results and USE-file, if a directory is not set, WinPHOTON will use the current directory.

In animation mode, users can interrupt drawing via the ESCAPE key. In other cases users can enter character "/" in window *Command Console* and press *Run*.

Users can also select the *Draw-> Transience command* and window *Transience command* opens as shown in Figure 3.27.
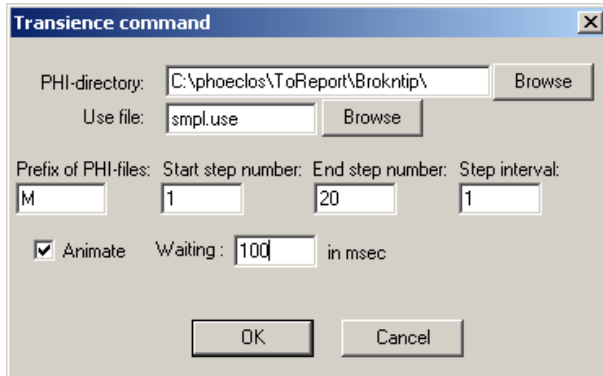

Figure 3.27

Users can select a working directory. The best way is via *Browse*, selecting the last file of the calculation of the non-stationary process. Some fields in the window will be entered automatically (*prefix of PHI-files, First number, Last number* and *Step*). Users can then select the created USE-file, check *Animate* and set the duration of the pause in milliseconds. If *Animate* is unchecked then the mode "frame-by-frame" will be selected.

The command `TRANSience` will be generated after pressing *OK*, for example
```
TRANS M    1  20   1 trans.use      200
C:\phoeclos\ToReport\Brokntip\
```

In animation mode, the *Command Console* window will be hidden. The execution of command `TRANSience` executes the USE-file commands sequentially for each file of calculation results.

4. **AUTOPLOT Interface**

AUTOPLOT is a part of WINPHOTON designed to produce labelled plots of numerical data in the form of graphs showing the variation of variables one against another.

To use AUTOPLOT select menu *Run->Autoplot* which will change the main menu. As with PHOTON, users can work in the *Command Console* window and, when AUTOPLOT is run, it will store the commands entered during the session in a file. The file is written in USE-file format, which can be read by AUTOPLOT to recreate the session at a later time. Users can also use dialog windows which give wider possibilities than standard command mode.

4.1   Opening Files
Users should open one, or several, data files when starting AUTOPLOT.

4.1.1   Open Data Files
To open files containing data, select menu item *File->Data Files* and window *Opened Files* will open as shown in Figure 4.1.
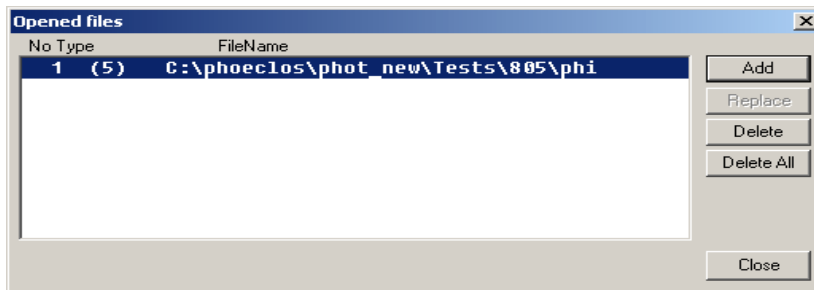
Figure 4.1

Users can add a data-file, delete one data-file or delete all files simultaneously. New data files can be added via the *Add* button and the *Open File* window will open as shown in Figure 4.2.
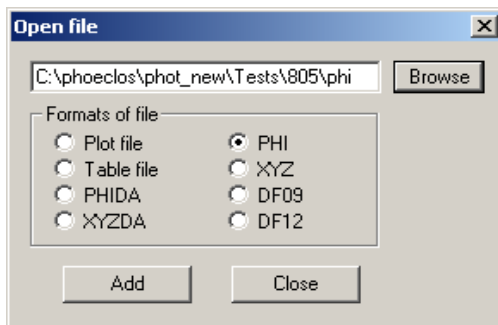
Figure 4.2

Users can select files via *Browse* and set the file type. Detailed information about types of data-files can be found in [2]. The *Add* button closes *Open File* and the selected file will appear in a list of files in *Opened Files.*

AUTOPLOT generates sets of commands, for example:
```
File
C:\phoeclos\ToReport\Brokntip\M6 5
```

4.1.2   Open Use Files

AUTOPLOT handles USE-file in the same way as WinPHOTON. To use this feature users must create a USE-file containing AUTOPLOT commands and select menu item *File->Open Use File.* Working in AUTOPLOT, via the *Open Use File* window as shown in Figure 4.3, is fully analogous to working with the same window of WinPHOTON. A detailed description is to be found in 3.2.1
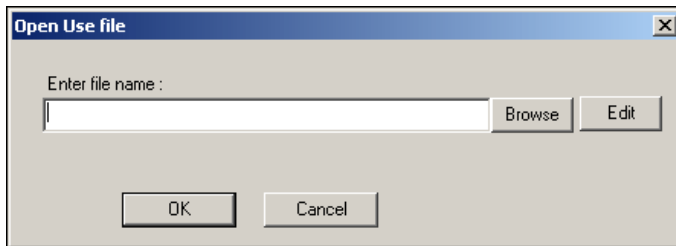

Figure 4.3

4.2   Data for Plotting

Graphics are created via a series of data using *Command->Datas.* This opens the *Data Elements* window as shown in Figure 4.4.
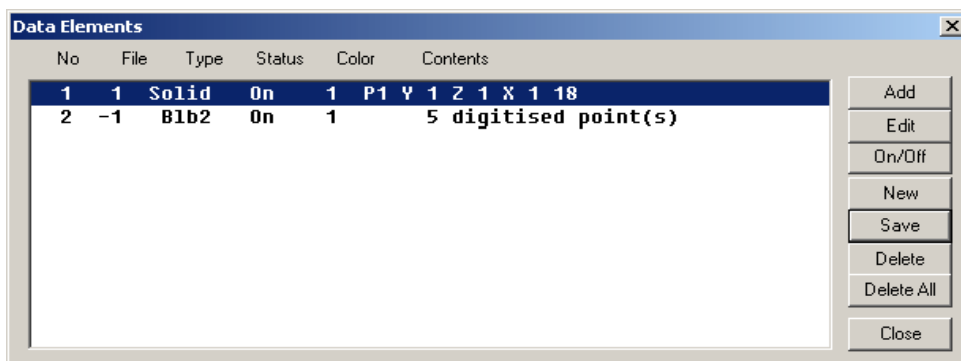
Figure 4.4

Users can select any object from those listed and add or edit data (A*dd* or *Edit* buttons), change visibility (*ON/OFF* button), save the series to a separate file (*Save* button); and delete one series or all series (*Delete* or *Delete All* buttons). Users can create new series and enter data in separate windows via the *New* button. Data series created by this method cannot be edited later so users must delete and recreate any such series.

To add new data series from an open file use the *Add* button which opens the *Adding Data Element* window as shown in Figure 4.5.
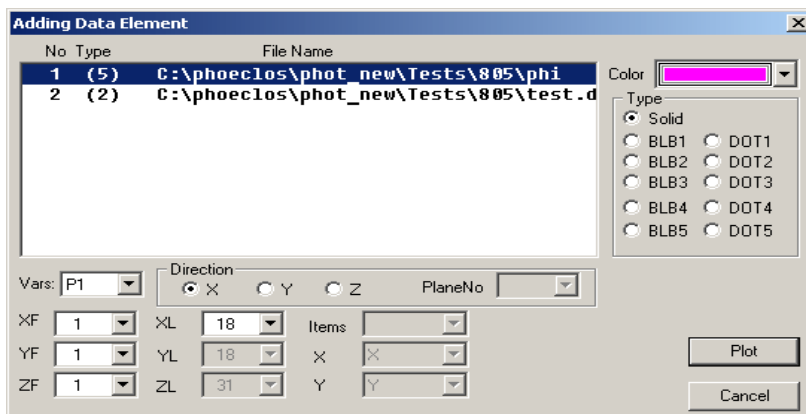

Figure 4.5

Users can select data files. For various types of files controls can be enabled or disabled. For the `PHI` file, users select variable names, abscissa directions, the number of first and last points in the series and set colour and line type.

Command sets will be generated using the *Plot* button, for example:
```
DATA  1
P1 Z   1 Y   1  50
SCALE
BLB2  1
```

To create a new data series without connecting to an open file, users press button *New* in the *Data Elements* window. The window *New data set* opens as shown in Figure 4.6.
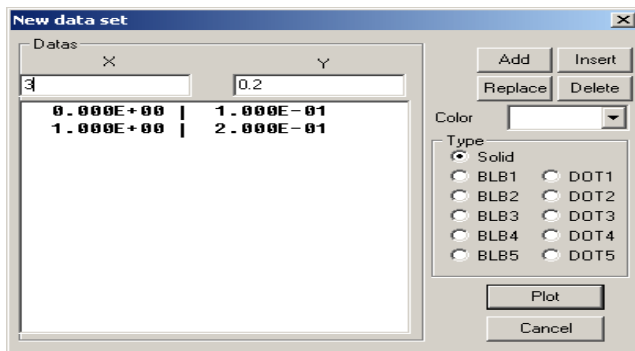
Figure 4.6

Users can enter data in windows X and Y, form data series and use:
- *Add* to add these data to the end of series,
- *Insert* to insert before selected line,
- *Replace* to replace selected line
- *Delete* to delete selected line.

Data in series should be ordered by increasing X. Users must check entered data because, after pressing the *Plot* button, data cannot be changed. Command sets will be generated after pressing on button *Plot*:
```
SCALE
REDRAW
```

4.3   Add-on elements

Users can create add-on graphical elements for better performance. The following objects relate to this: TEXTS, KEYS и LEVELS.

4.3.1   Text and key elements
To create objects TEXTS and KEYS users can select menu item *Command->Texts*. The window *List of text elements* opens as shown in Figure 4.7.
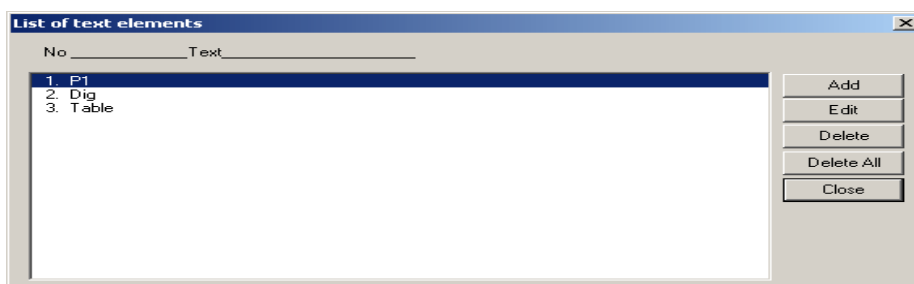

Figure 4.7

Users can use buttons *Add* and *Edit* to add or edit objects; buttons *Delete* and *Delete All* to delete selected object or all objects; and button *Close* to close window. Buttons *Add* or *Edit* open windows *Add and Edit of Text elements and select Keys* as shown in Figure 4.8.
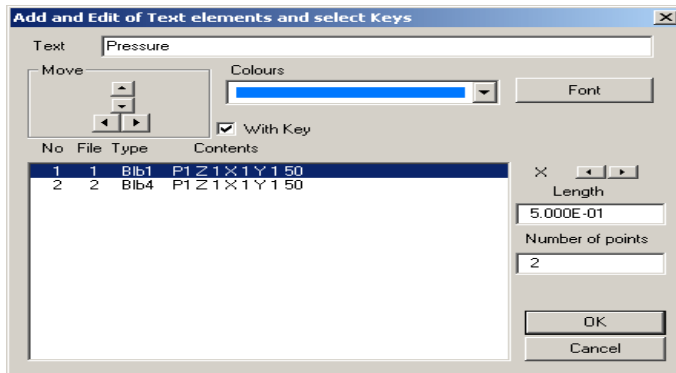

Figure 4.8

Using this window users can set parameters of object: enter text, set the font of text, select colour of text from combo box *Colours* (not from standard window of font parameters). The AUTOPLOT as WINPHOTON draws TEXT object always on main window therefore users can see always all changes. Users can move text on screen using arrows.

If users want to create KEY objects together with TEXT objects then the *With Key* box should be checked and DATA object for KEY element selected. Users can replace the KEY object relative to TEXT using arrows, change length of object KEY and amount of points for drawing of KEY. ????

After pressing the *OK* button all entered information will be saved and command REDRAW will be generated to redraw the image on the screen.

4.3.2   Levels
If users may want to mark the defined level on axes abscissa or ordinate. This can be done by create object LEVEL. Users select menu item *Command->Levels* and the *Levels* window will be opened as in Figure 4.9.
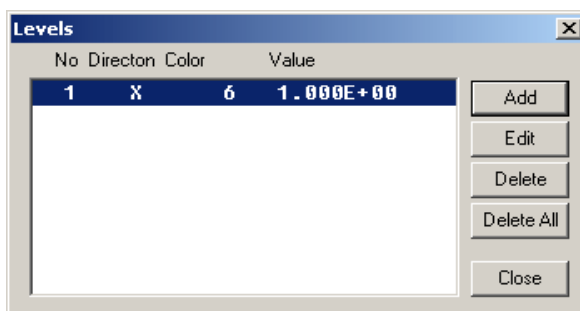

Figure 4.9

Users can use *Add* and *Edit* to add or to edit objects, *Delete* and *Delete All* to delete selected object or all object accordingly, and *Close* to close windows. The *Add* or *Edit* buttons open the *Edit Level* window as shown in Figure 4.10.
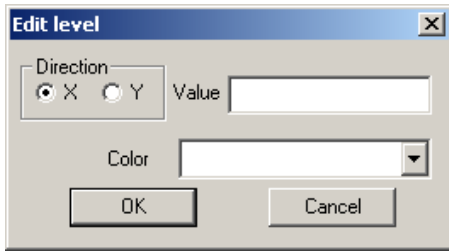
Figure 4.10

Users can set level direction, value of axes for level, colour of level. The LEVEL object is created by the *OK* button and drawn on main window.

4.4   Settings

Users can change most AUTOPLOT parameters using commands in window *Command Console*. Some of command users can send using dialog windows.

4.4.1   Set colours

Users can change the colours of general elements in the main window via menu item *Setting->Set Colours*. The *Colours* window opens as shown in Figure 4.11.
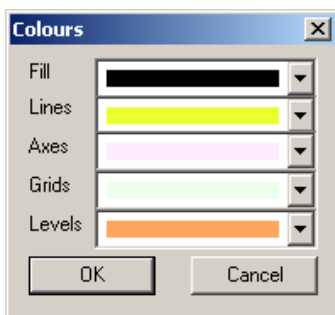

Figure 4.11

Users can change colours of background, lines, axes, grids and levels set by default.

4.4.2   Set keep parameters

Sometimes users want to delete all graphics except add-ons, for example, TEXTS objects. This can be done via the KEEP command or by selecting menu item *Setting->Keep parameters* which opend the *Keep* window as shown in Figure 4.12.
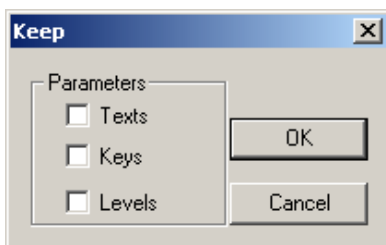

Figure 4.12

Users must check the check boxes to keep needed objects and then press *OK*. A set of AUTOPLOT commands will be executed, for example:

```
TEXT KEEP
KEY KEEP
```

4.4.3 Set scale

If users want to change scales of axes on graphic this can be done via menu item *Setting->Scale* which opens the *Scale* window as shown in Figure 4.13.
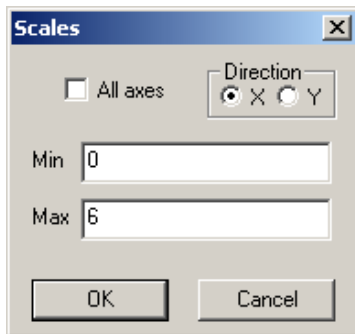

Figure 4.13

If the *All axes* box is checked and *OK* is pressed, then the SCALE command will be executed and scales will be recalculated automatically.

If users want to set scale on axes manually then the *All axes* should be unchecked and the direction of axes on which the scale is to be changed should be entered. Maximum and minimum values for these axes should be specified and the *OK* button pressed. A set of commands will be generated, for example:

SCALE X
  0.000E+00 6.000E+00

4.4.4 Set grids

If users want to draw grids on graphics, this can be done via menu item *Setting->Grid*. The window *Grid* will be opened as shown in Figure 4.14.
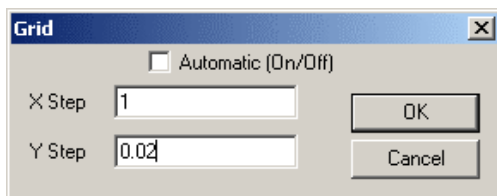

Figure 4.14

If users check the *Automatic (On/Off)* box and press *OK* then command GRID will be executed and a grid will be created automatically.

If users want to set the grid manually, it is necessary to uncheck the *Automatic (On/Off)* box, set values of grid step on each direction and press *OK*. A command of the following type will be generated:

GRID DEFINE 1.000E+00 1.000E+01